THE

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY

OF ENGLAND.

VOLUME THE TWENTIETH.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

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APPENDIX.

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the *end* of each volume of the Journal, excepting Titles and Contents, and Statistics, &c., which are in all cases to be placed at the *beginning* of the Volume: the lettering at the back to include a statement of the *year* as well as the *volume*; the first volume belonging to 1839–40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

In Reprints of the Journal all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

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STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING JUNE 30, 1859.

Chiefly extracted from the Quarterly Report of the Registrar-General.—The Corn Returns and Diagram are prepared from Official Documents expressly for this Journal.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING MARCH 31, 1859.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

Till the 9th of January the temperature was alternately in excess and defect; the mean for that period being nearly that of the average. On the 10th a warm period set in, which continued till the end of the quarter. The excess of temperature in January over the average of 88 years was 4°·4; in February 4°·9; and in March 5°·5. The average excess of daily temperature for the 80 days, from Jan. 10 to March 31, was 5°·3. The days of February and the nights of March were remarkably warm.

The mean of the three months ending the 31st of March was 43°·3; that of the average of 88 years was 38°4·; so that the excess upon the whole quarter was very nearly 5°. Since 1771 the mean temperature of the first three months of the present year has only been twice exceeded: namely in 1822, when the mean was 43°·5; and in 1846, when it was 43°·6.

The mean temperature of the dew-point was above its average in each month, but by less amount than the excess of temperature; consequently though there was more water present in the air than usual, yet the air was less humid in each month than the average.

The reading of the barometer was very high in January, and slightly in excess in February and March. The readings in the three months were highest at southern stations, gradually decreasing to the lowest at northern stations.

The fall of rain was deficient in each month at all the southern stations, excepting Cornwall and Devonshire; only one-half of the average fell in January and February. The deficiency was not so great at northern stations. At Greenwich the fall in the five years ending 1853 was 131 inches; in the five years ending 1858 it was 104 inches: the difference exceeds 1 year's fall. There was a remarkable rain at Bristol on the 11th, 12th, and 13th of March, amounting to 3·29 inches.

The mean temperature of the air at Greenwich for the quarter ending February, constituting the three winter months, was 41°·5, being 3·8 above the average of 88 years.

The Weather during the Quarter ending March 31, 1859.

1859. Months.	Temperature of Air. Mean.	Air. Diff. from average of 88 years.	Air. Diff. from average of 18 years.	Evaporation. Mean.	Evaporation. Diff. from average of 18 years.	Dew Point. Mean.	Dew Point. Diff. from average of 18 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 18 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 18 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 18 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
January ..	40·4	+4·4	+2·3	38·9	+1·9	37·0	+1·7	10·0	+0·5	·220	+·016	2·6	+0·2
February ..	43·1	+4·9	+4·8	40·6	+3·8	37·6	+3·2	14·1	+3·0	·225	+·024	2·6	+0·3
March	46·4	+5·5	+4·8	43·4	+4·2	40·0	+3·8	13·7	−1·1	·247	+·032	2·8	+0·3
Mean ..	43·3	+4·9	+4·0	41·0	−3·3	38·2	+2·9	12·6	+0·8	·231	+·024	2·7	+0·3

1859. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 18 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 18 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 18 years.	Rain. Amount.	Rain. Diff. from average.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
January ..	88	−1	30·037	+·290	557	+3	0·8	−0·8	124	14	15	2	22·0	41·5
February ..	81	−5	29·823	+·042	550	−4	0·9	−0·7	150	12	15	1	24·4	41·0
March	79	−3	29·806	+·006	546	−5	1·3	−0·1	130	5	12	14	17·0	49·1
Mean ..	83	−3	29·889	+·113	551	−2	Sum 3·1	Sum −1·6	Mean 135	Sum 31	Sum 42	Sum 17	Lowest 17·0	Highest 49·1

Note.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING JUNE 30, 1859.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

TILL the 11th of April the air was warm, being 7° above the average; till May 23rd for the most part cold, the average daily defect being 2½° nearly; and from May 24th to the end of the quarter it was almost always warm; the average daily excess of temperature being 3° nearly.

Till April 11th the wind was from the S.W., passing at the rate of 170 miles daily; to May 23rd it was mostly N.E., with a daily horizontal movement of nearly 100 miles; till June 20th it was N.E. and S.E., and S.W. from June 21st till the end of the quarter. The average daily movement for these last 37 days was 55 miles.

The mean temperature of April was 0°·1, of May 0°·3, and of June 2°·3, above the average for the last 18 years. Both night and day temperatures in the months of April and May were very nearly of their average value; and both these elements were high in June, and therefore the days and nights in this month were warm.

The mean temperature of the dew-point was below its average value in April, and above it in May and June. The mean degree of humidity of the air in April and May was very nearly of its average value, and was in excess in June. The air, therefore, in June was somewhat humid.

The reading of the barometer was below the average in April and June, and somewhat above it in May. It increased from April to May at all places, the increase being greatest at northern stations.

The fall of rain in the quarter was nearly that of its average. The deficiency from the beginning of the year is 1¾ inch. The deficiency in the years 1854, 1855, 1856, 1857, and 1858, amounts to the average fall of one year, viz. 25 inches. From a careful examination of the fall of rain from the year 1815, it would seem that the annual fall is becoming smaller, and that there is but little probability that this large deficiency will be made up by excesses in future years.

The mean temperature of the air at Greenwich for the three months ending May, constituting the three Spring months, was 48°·7, being 2°·3 above the average of 88 years.

The Weather during the Quarter ending June 30, 1859.

1859. Months.	Temperature of Air. Mean.	Air. Diff. from average of 88 years.	Air. Diff. from average of 18 years.	Evaporation. Mean.	Evaporation. Diff. from average of 18 years.	Dew Point. Mean.	Dew Point. Diff. from average of 18 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 18 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 18 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 18 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April	46·6	+0·8	+0·1	43·4	−0·1	38·9	−1·2	17·8	−0·4	·237	−·012	2·8	−0·1
May	53·1	+0·6	+0·3	49·6	+0·5	45·9	+0·5	21·0	+0·8	·312	+·013	3·6	+0·2
June	61·4	+3·3	+2·3	57·3	+2·5	53·8	+3·0	20·9	−0·4	·415	+·043	4·6	+0·5
Mean ..	53·7	+1·6	+0·9	50·1	+1·0	46·2	+0·8	19·9	0·0	·321	+·015	3·7	+0·2

1859. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 18 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 18 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 18 years.	Rain. Amount.	Rain. Diff. from average of 44 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Number of Nights it was Between 30° and 40°.	Number of Nights it was Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
April	78	−1	29·614	−·125	542	−2	2·2	+0·4	133	10	9	13	18·0	48·0
May	77	+1	29·789	+·028	538	0	2·4	+0·3	75	3	14	14	26·0	50·5
June	77	+4	29·766	−·039	528	−3	1·4	−0·5	57	0	0	30	40·0	58·7
Mean ..	77·3	+1	29·723	−·045	536	−2	Sum 6·0	Sum −0·2	Mean 88	Sum 13	Sum 23	Sum 57	Lowest 18·0	Highest 58·7

Note.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) signifies above the average.

STATE OF THE PUBLIC HEALTH.

1*st Quarter.*—121,682 deaths were registered in the quarter, being 4220 less than in the 1st quarter of 1858. The mortality was at the rate of rather more than 25 in 1000 (2·512 per cent.). The average mortality during the winter of the last ten years was 24·55 per cent. The rate has slightly decreased in the town districts; in the country districts it has increased from 2·218 to 2·354 per cent., or 1·36 in 1000.

2*nd Quarter.*—The number of deaths registered in the three months ending June 30th was 105,778. The rate of mortality was 2·153 per cent., or less by ·061 than the average rate of the season. In the large towns the mortality was at the rate of 2·238 per cent., or less by ·140 than the average. In the country districts and small towns the mortality was lower (2·061 per cent.) than in the denser districts, but greater than the average of country districts, so that instead of improvement there is deterioration. The sanitary condition of the country districts around the large towns now demands strict attention. The mortality of all England, if at the rate of the healthy districts, would be exactly 84,207, or 17 in 1000. The excess of 21,571 over this number are undoubtedly unnatural deaths, and may be ascribed to the unfavourable sanitary conditions in which a large portion of the population still lives.

PRICE OF PROVISIONS.

1*st Quarter.*—The price of wheat during the 13 weeks was 40*s.* 8*d.* a quarter; during the same period, 1857 and 1858, 56*s.* 10*d.* and 46*s.* 5*d.*: this shows a fall of 12 per cent. since March 1858. The price of potatoes also fell considerably, being 90*s.* a ton at the Waterside Market, Southwark, against 110*s.* and 152*s.* 6*d.* in 1857 and 1858. The mean prices per lb. of meat in the three winters 1857-8-9, were: beef 5¾*d.*, 5¼*d.*, 5¾*d.*; mutton 6¼*d.*, 6⅞*d.*, 6⅞*d.*

2*nd Quarter.*—The average price of wheat has risen from 40*s.* 8*d.* a quarter to 47*s.* 3*d.*, which is 7 per cent. above the price of the corresponding Spring quarter of the previous year. The price of beef by the carcase at Leadenhall and Newgate Markets has gone up to 5⅝*d.* a pound, or 10 per cent. higher than in the second quarter of 1858; mutton has risen to 6*d.* a pound, or 9 per cent. higher than in the same period of 1858. Potatoes have risen from 90*s.* to 97*s.* 6*d.* a ton at the Waterside Market, Southwark; they are 40 per cent. cheaper than in the same months of last year.

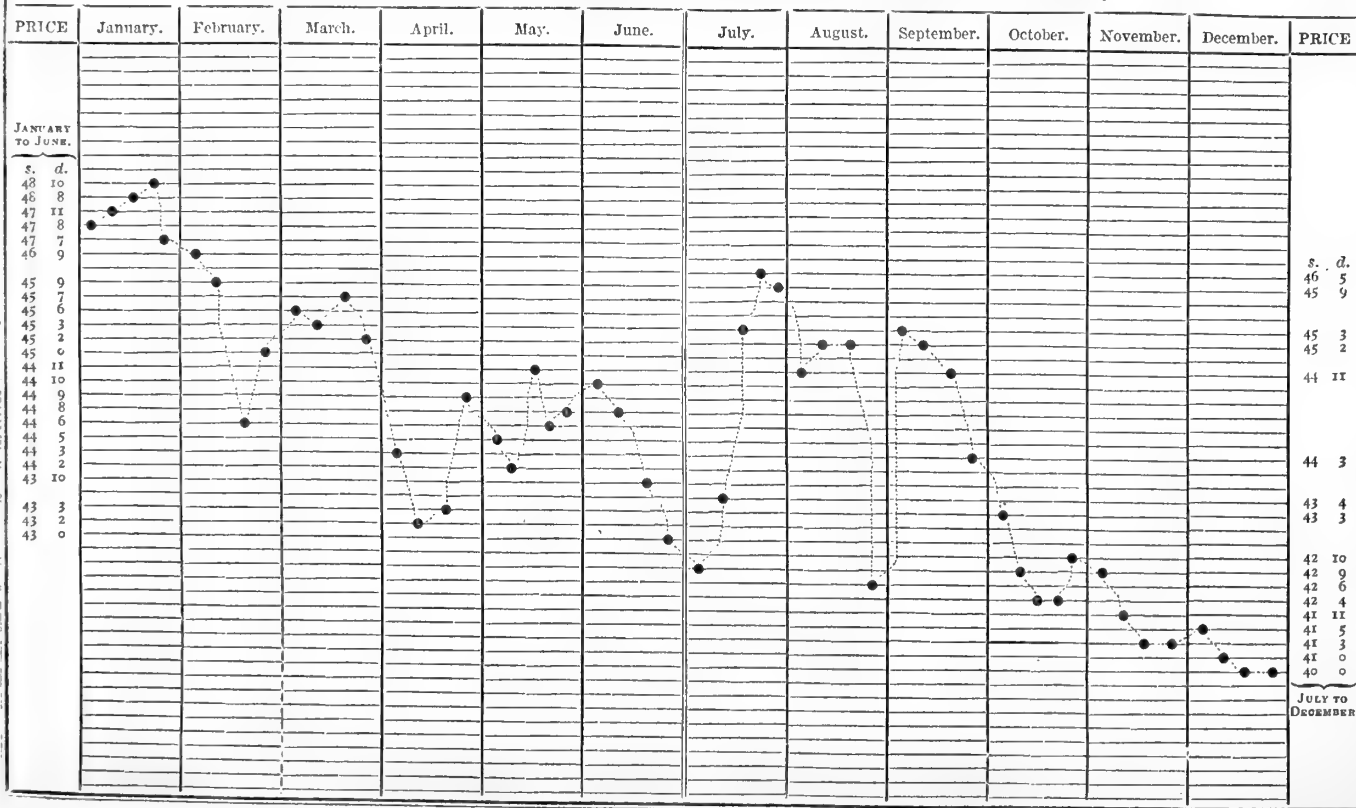
THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending June 30th, 1859.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase). Beef.	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase). Mutton.	Average Prices of Potatoes (York Regents) per Ton at Waterside Market, Southwark.
			Average number of Quarters weekly.				
	£.	s. d.					
1857 June 30	$93\frac{3}{8}$	56 9	107,850	42,178	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{5}{8}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	105*s.*—150*s.* Mean 127*s.*6*d.*
Sept. 30	$90\frac{7}{8}$	59 11	92,156	55,384	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{3}{8}d.$	$4\frac{1}{2}d.$—$7d.$ Mean $5\frac{3}{4}d.$	95*s.*—115*s.* Mean 105*s.*
Dec. 31	$89\frac{1}{2}$	52 0	101,025	95,587	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{3}{8}d.$	$4\frac{1}{2}d.$—$7d.$ Mean $5\frac{3}{4}d.$	130*s.*—150*s.* Mean 140*s.*
1858 Mar. 31	$96\frac{1}{8}$	46 5	99,604	64,652	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	130*s.*—175*s.* Mean 152*s.*6*d.*
June 30	$97\frac{1}{8}$	44 1	92,955	86,551	$4\frac{1}{4}d.$—$6d.$ Mean $5\frac{1}{8}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	140*s.*—185*s.* Mean 162*s.*6*d.*
Sept. 30	$96\frac{4}{8}$	44 7	97,307	82,373	$4\frac{1}{2}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	65*s.*—90*s.* Mean 77*s.* 6*d.*
Dec. 31	$98\frac{1}{4}$	41 9	110,437	54,413	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{1}{2}d.$	80*s.*—95*s.* Mean 87*s.* 6*d.*
1859 Mar. 31	$95\frac{5}{8}$	40 8	103,637	46,139	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	80*s.*—100*s.* Mean 90*s.*
June 30	$92\frac{7}{8}$	47 3	96,514	99,533	$4\frac{3}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{5}{8}d.$	$5d.$—$7d.$ Mean $6d.$	85*s.*—110*s.* Mean 97*s.* 6*d.*
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending June 30th, 1857, was 1,402,051; for the 13 weeks ending September 30th, 1857, 1,198,029; for the 13 weeks ending December 31st, 1857, 1,313,321; for the 13 weeks ending March 31st, 1858, 1,294,855; for the 13 weeks ending June 30th, 1858, 1,208,420; for the 13 weeks ending September 30th, 1858, 1,264,996; for the 13 weeks ending December 31st, 1858, 1,435,678; for the 13 weeks ending March 31st, 1859, 1,347,277; and for the 13 weeks ending June 30th, 1859, 1,254,682. The total number of quarters entered for Home Consumption was respectively, 548,315; 719,992; 1,242,628; 840,475; 1,125,165; 1,070,845; 707,367; 599,807; and 1,293,925.

1858.—WEEKLY AVERAGE PRICE OF **WHEAT** FROM GOVERNMENT RETURNS.



	Wheat.	Barley.	Oats.	Beans.	Peas.	Maize.	Flour and Meal.
Average of Year	44/3	34/10	24/7	42/0	42/11	..	..
	qrs.	qrs.	qrs.	qrs.	qrs.	qrs.	cwt. qrs. lbs.
Import of United Kingdom .	4,275,435	1,672.602	1,878,313	414,983	159,484	1,762,320	3,900,384 0 . 6

STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING DECEMBER 31, 1859.

Chiefly extracted from the Quarterly Report of the Registrar-General.— The Corn Returns are prepared from Official Documents expressly for this Journal.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING SEPTEMBER 30, 1859.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

FROM the 1st July to the 27th of August the weather was unusually fine and hot. From August 28th to September 22nd a cold period prevailed; and from September 23rd to the end of the quarter the temperature was daily in excess. The temperature of the air in the shade reached 92½° on July 12, and 93° on the 13th and 18th; the mean temperature of these days was 75°·7, 75°·2, and 74°·3 respectively, and on seven other days in the month the mean temperature exceeded 70°. In the years 1826 and 1837 the mean temperature exceeded 70° on nine days; but back to the year 1814 there is no instance of 10 days in the month of July of such high temperature. It sometimes happens that several years together pass, as in the years 1838, 1839, 1840, 1841, and 1842, without any instance of a mean temperature for the day reaching 70°; and there was but one only in each of the three following years 1842, 1843, and 1844. The mean temperature of the month was 68°·1, whilst its average is 61°·4; the excess, therefore, for the whole month was 6°·7. The month of August was for the most part warm; its mean temperature was 63½°, showing an excess of 3° nearly. September was chiefly cold till the 22nd, and very warm from the 23rd; its mean temperature was 56¾°, being ¼° above the average of 88 years. The mean temperature for the three months ending September was 62°·8. In 1779 it was 63°·2; 1818, 63°·5; 1846, 62°·6; and 1857, 63°·3; in all other years since 1771 it has been less than 62¾°; so that in three corresponding periods only, during an interval of 88 years, has the temperature of the quarter been exceeded.

The mean temperature of the dew-point was above its average value in July, about its average in August, and below it in September. The excess, however, of temperature in July being greater than the excess of temperature of the dew-point, and the comparative high temperature of the other two months, caused the degree of humidity of the air to be less than usual throughout the quarter.

The pressure of the atmosphere was greater than its average in July, of nearly its usual value in August, and less in September. The decrease in the readings of the barometer from month to month was about 0·1 inch, and was unusually uniform all over the country.

The fall of rain in the quarter exceeded its average by 0·7 inch. The deficiency upon the year is thus reduced to ¾ inch only.

The mean temperature of the air at Greenwich for the three months ending August, constituting the three summer months, was 64°·3, being 4°·3 above the average of 88 years.

THE WEATHER DURING THE QUARTER ENDING SEPTEMBER 30, 1859.

1859. Months.	Temperature of Air. Mean.	Air. Diff. from average of 88 years.	Air. Diff. from average of 18 years.	Evaporation. Mean.	Evaporation. Diff. from average of 18 years.	Dew Point. Mean.	Dew Point. Diff. from average of 18 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 18 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 18 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 18 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
July	68·1	+6·7	+6·5	62·6	+5·2	58·3	+4·6	24·6	+4·1	·487	+·063	5·4	+0·8
August ..	63·5	+2·8	+2·1	58·4	+0·9	54·2	+0·1	21·8	+2·3	·421	-·002	4·7	+0·0
September ..	56·7	+0·3	-0·4	52·7	-1·4	50·0	-1·2	18·1	-0·5	·361	-·023	3·9	-0·3
Mean ..	62·8	+3·3	+2·7	57·9	+1·6	54·2	+1·2	21·5	+2·0	·423	+·013	4·7	+0·2

1859. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 18 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 18 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 18 years.	Rain. Amount.	Rain. Diff. from average of 44 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July	70	-6	29·937	+·142	524	-3	3·3	+0·6	57	0	0	31	40·5	60·7
August ..	72	-5	29·818	+·019	527	-1	1·1	-1·3	86	0	0	32	40·1	60·0
September ..	75	-6	29·709	-·130	532	-2	3·8	+1·4	97	0	9	21	35·0	64·3
Mean ..	72	-6	29·821	+·010	528	-2	Sum 8·2	Sum +0·7	Mean 80	Sum 0	Sum 10	Sum 84	Lowest 35·0	Highest 64·3

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING DECEMBER 31, 1859.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

FROM October 1st to the 20th the weather was very fine, and the average excess of daily temperature was 6°. On the 21st a sudden and very severe cold set in; the depressions below their average temperature on the 21st and 22nd exceeded 12° on both days, and were as much as 15° below on the 23rd, and nearly 16° on the 24th; the daily average defect of temperature from October 21st to the end of the month, was $8\frac{1}{2}$° nearly. From November 1st to 8th was warm; the daily excess of temperature was $3\frac{3}{4}$°. A cold period set in on November 9th, and continued, with the exception of a very few days, to December 23rd; the cold was very severe between December 14th and 19th, particularly so from 16th to 19th; the defect of temperature on these days amounting to 15°, 17°, $16\frac{1}{2}$°, and $15\frac{1}{2}$° respectively; the average daily defect of temperature for the 45 days ending December 23rd was $2\frac{1}{4}$°. From December 24th to the end of the year was warm, particularly on the last two days, when excesses of temperature over their averages were 13° and 15° respectively, and for the eight days ending December 31st averaged 8° daily.

Both the days and nights in October were moderately warm; in November the days were of their average warmth, but the nights were cold; and both the days and nights in December were very cold.

The mean temperature of October was $1\frac{1}{4}$° in excess; November was $1\frac{1}{2}$°, and December was $3\frac{1}{4}$° in defect, as compared with the average of the 18 preceding years.

The mean temperature of the whole year was 50°·8, being 2°·5 above the average of 88 years.

The mean temperature of the dew-point was above its average in October, and below it in November and December. The degree of humidity for the quarter is that of the average.

The reading of the barometer was low in October; it increased 0·3 inch generally by November, and was 0·2 inch lower in December than in the preceding month.

The fall of rain in the quarter was $8\frac{3}{4}$ inches, exceeding the average by 1·6 inch. The fall in the year amounted to 25·9 inches, exceeding the average by half an inch; this is the first year since 1854 that the fall of rain has not been short of the average.

The mean temperature of the air at Greenwich for the three months ending November, constituting the three autumn months, was 49°·9, being 0°·7 below the average of 88 years.

THE WEATHER DURING THE QUARTER ENDING DECEMBER 31, 1859.

1859. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 88 years.	Air. Diff. from average of 18 years.	Evaporation. Mean.	Evaporation. Diff. from average of 18 years.	Dew Point. Mean.	Dew Point. Diff. from average of 18 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 18 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 18 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 18 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
October ..	50·9	+1·0	+1·3	49·4	+1·3	47·9	+2·1	14·0	−0·7	·334	+·024	3·7	+0·2
November	42·1	−0·3	−1·5	40·4	−1·6	38·3	−2·0	13·9	+2·4	·231	−·026	2·6	−0·3
December	36·8	−2·2	−3·7	35·4	−3·6	33·4	−3·9	9·7	+0·2	·191	−·038	2·2	−0·4
Mean ..	43·3	−0·5	−1·3	41·7	−1·3	39·9	−1·3	12·5	+0·6	·252	−·013	2·8	−0·2

1859. MONTHS.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 18 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 18 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 18 years.	Rain. Amount.	Rain. Diff. from average of 44 years.	Daily Horizontal movement of the Air.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
October ..	89	+2	29·523	−·168	535	−4	3·6	+0·8	..	8	3	20	20·0	56·0
November	87	−2	29·824	+·068	551	+4	2·9	+0·5	..	20	6	4	18·2	45·0
December	88	−1	29·623	−·209	553	+1	2·2	+0·3	..	24	5	2	11·0	43·0
Mean ..	88	0	29·657	−·103	546	0	Sum 8·7	Sum +1·6	Mean ..	Sum 52	Sum 14	Sum 26	Lowest 11·0	Highest 56·0

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

STATE OF THE PUBLIC HEALTH.

1*st Quarter.*—104,339 persons died in the quarter, being 6079 in excess of the deaths, 98,260, in the corresponding summer quarter of the previous year; the rate of mortality, 2·093 per cent., is below the average (2·138). The deaths in the quarter would not have exceeded 73,533 if the mortality in sixty-three districts of England, by no means in unexceptionable sanitary condition, be taken as the standard. The 30,806 deaths in excess are unnatural deaths, the results of causes which it is the duty of every member of the community to endeavour to remove. The mortality of the quarter in the small towns and the country parishes was above their average, to the extent of more than *one* death annually out of every 1000 living. In the large town districts the reverse was observed; the mortality having been at the rate of 2 in 1000 less than the average.

2*nd Quarter.*—The births exceeded the deaths by 60,641, and that was therefore nearly the natural increase of the population in 92 days. Thus the population of England and Wales increased at the rate of 659 daily; and the probable natural increase of the population of the United Kingdom was 988 daily. In the year the excess of births over deaths was 248,309, or 680 daily in England and Wales; in the United Kingdom the natural increase must have exceeded 1000 daily. 109,450 deaths were registered in the last quarter of the year 1859, and the mortality was at the rate of 2·189 per cent. per annum. This is slightly above the average rate (2·183); but it is much below the rates in the corresponding quarters of the two previous years (2·263 and 2·402). In the last year 441,249 deaths were registered; and the mortality was at the rate of 2·235 per cent.; or rather more than 22⅓ died out of 1000 living. It appears that the deaths should not have exceeded 322,616 in the year, at what may be provisionally called the natural rate, actually prevailing in the sixty-three healthy districts. The 118,633 deaths in excess of this number were, therefore, unnatural deaths. During ten previous autumn quarters the town population, it is found, died at the rate of nearly 25 in 1000; the country population at the rate of 19 in 1000. In the last quarter the mortality of the towns was between *one* and *two* in 1000 below the average. This reduction may be fairly referred to the active employment in the manufacturing districts, and to the partial sanitary improvements which have been made in several large towns. That it is not the effect of the weather, or of any universal cause, is proved by the fact that in the country and small town districts the mortality rose from the average of 19 to 20 deaths out of 1000 living.

PRICE OF PROVISIONS.

1st Quarter.—The price of wheat has remained steadily at nearly the same figure for a year and nine months; and during the last three months it has been 44*s.* a quarter. This steadiness of price in an article of large consumption has a salutary effect. Beef has been 5¼*d.* a pound, mutton 5¾*d.* a pound by the carcase at Leadenhall and Newgate Markets. The price of beef is the same as it was in the corresponding quarter of 1858, and the eighth of a penny less than it was in 1857; the price of mutton in the same quarters was 5¾*d.*, 5½*d.*, and 5¾*d.* The average prices of the higher qualities of the two meats decreased ¼*d.* in the pound; or beef from 6½*d.* to 6¼*d.*; mutton 7*d.* to 6¾*d.* Potatoes were sold at the rate of 85*s.* a ton at the Waterside Market, Southwark; in the corresponding quarters of two previous years the prices were 105*s.* and 77*s.* 6*d.* The prices of the present year occupy an intermediate position between those of 1857, when they were higher, and 1858, when they were lower.

2nd Quarter.—Wheat was sold at the average rate of 43*s.* 4*d.* a quarter during the last thirteen weeks of the year 1859; in the corresponding weeks of 1857 and 1858 the price was 52*s.* and 41*s.* 9*d.* The price of this great article of food fluctuated little, and has been moderate during the last two years. The average price of beef by the carcase at Leadenhall and Newgate Markets was 5¼*d.*, of mutton, 5¾*d.* a pound. The price of meat fluctuates less than the price of bread; but taking the mean of two articles, the price has followed the same course as the price of wheat. So the price of potatoes, which fluctuates largely, and has an evident effect on the public health, was 140*s.*, 87*s.* 6*d.*, and 102*s.* 6*d.* a ton in the last thirteen weeks of the three years 1857, 1858, and 1859.

THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending December 31st, 1859.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.	Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of: Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Average Prices of: Potatoes (York Regents) per Ton at Waterside Market, Southwark.
			Average number of Quarters weekly.		Beef.	Mutton.	
1857 Dec. 31	£. $89\frac{1}{2}$	s. d. 52 0	101,025	95,587	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{3}{8}d.$	$4\frac{1}{2}d.$—$7d.$ Mean $5\frac{3}{4}d.$	130s.—150s. Mean 140s.
1858 Mar. 31	$96\frac{1}{8}$	46 5	99,604	64,652	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	130s.—175s. Mean 152s. 6d.
June 30	$97\frac{1}{8}$	44 1	92,955	86,551	$4\frac{1}{4}d.$—$6d.$ Mean $5\frac{1}{8}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	140s.—185s. Mean 162s. 6d.
Sept. 30	$96\frac{4}{8}$	44 7	97,307	82,373	$4\frac{1}{2}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	65s.—90s. Mean 77s. 6d.
Dec. 31	$98\frac{1}{4}$	41 9	110,437	54,413	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{1}{2}d.$	80s.—95s. Mean 87s. 6d.
1859 Mar. 31	$95\frac{5}{8}$	40 8	103,637	46,139	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	80s.—100s. Mean 90s.
June 30	$92\frac{7}{8}$	47 3	96,514	99,533	$4\frac{3}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{5}{8}d.$	$5d.$—$7d.$ Mean $6d.$	85s.—110s. Mean 97s. 6d.
Sept. 30	$95\frac{3}{8}$	44 0	85,707	50,291	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	65s.—105s. Mean 85s.
Dec. 31	$96\frac{1}{8}$	43 4	127,361	44,911	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	85s.—120s. Mean 102s. 6d.
Col.	1	2	3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending December 31st, 1857, was 1,313,321; for the 13 weeks ending March 31st, 1858, 1,294,855; for the 13 weeks ending June 30th, 1858, 1,208,420; for the 13 weeks ending September 30th, 1858, 1,264,996; for the 13 weeks ending December 31st, 1858, 1,435,678; for the 13 weeks ending March 31st, 1859, 1,347,277; for the 13 weeks ending June 30th, 1859, 1,254,682; for the 13 weeks ending September 30th, 1859, 1,114,191; and for the quarter ending December 31st, 1859 (14 weeks), 1,783,050. The total number of quarters entered for Home Consumption was respectively, 1,242,628; 840,475; 1,125,165; 1,070,845; 707,367; 599,807; 1,293,925; 653,789; and 583,848.

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

THE following Report on the Preservation of Timber has been presented to the Society by the North-Eastern Railway Company. It embodies the results of experiments undertaken by Dr. Richardson for that Company, extending over a period of some years.

The importance of the question to railway companies may be gathered from the fact that the money value of the timber consumed by the North-Eastern Company alone has for the last three years considerably exceeded 60,000*l.* per annum.

The subject is treated exclusively with reference to the preservation of timber in large quantities, for consumption in the construction and maintenance of railways, docks, and other important works of a similar kind; but the Report contains a large amount of information which cannot fail to be interesting to all landed proprietors, and, in fact, to all residents in the country who have any quantity of gates, palings, &c., to keep in repair.

The Report, as presented to the Society, has an Appendix containing abstracts of the Specifications relating to the Preservation of Timber attached to the various Patents taken out for this purpose from 1728 to 1858. This portion of the Report, on account of its length, is not published in the Journal; but those who take sufficient interest in the subject can consult the original pamphlet in the Society's library in Hanover-square. One quotation only from this Appendix will be made here, viz., a portion of the specification of the *earliest* patent granted (9th May, 1728). It professes to make known a method of "Preserving plank and sheathing of ships, which will not only prevent the worms and other small insects from eating and fouling their bottoms, but enable the ships so sheathed, even in their long voyages, to *outsail any other ships of the same burthen.*" This patent was either so successful as apparently to supersede the necessity of further improvements, or so complete a failure as to discourage several successive generations from making any further attempts of the kind; for it appears that no subsequent application for a patent for the preservation of timber was made from 1728 until the taking out of Mr. Kyan's patent in 1832 for the preservation of timber by soaking or boiling in a solution of corrosive sublimate. Since that date the increasing

importance of the subject, and the additional attention paid to all scientific inquiries connected with industrial pursuits, have greatly augmented the applications for patents, no less than 50 having been taken out with this object between 1832 and 1858.

Dr. Richardson's Report gives an interesting summary of the various modes and materials suggested for protecting the surface of timber or preserving its substance, and the result at which he arrives, viz., that any waste or refuse wood, even though in an advanced stage of decay, may be distilled into products of great value for the preservation of timber, is an important discovery which before long will probably be made available for the preservation of the timber so largely required for agricultural buildings and fences; whilst Armstrong's patent, taken out in 1858, for mounting the apparatus used for impregnating wood with any preservative fluid, on carriages and wheels suitable for running on railways or common roads, promises to make the invention generally available.—H. S. T.

I.—*Report on the Preservation of Timber.* By Thomas Richardson, F.R.S.E., Professor of Chemistry in the University of Durham.

Nature of Wood.—The tissues of wood are composed of a substance termed *cellulose*, more or less incrusted with a hard and brittle organic matter, which is more abundant in hard and heavy, than in the soft and light, woods. This substance contains more hydrogen than is necessary to form water with the oxygen. The differences noticed in the composition of *Lignine*, which was supposed to be the pure principle of wood, are due, according to Payen, to the presence of this incrusting substance. He has found it to contain four allied principles, which he has distinguished by the names of *Lignose*, *Lignone*, *Lignin*, and *Lignireose*.

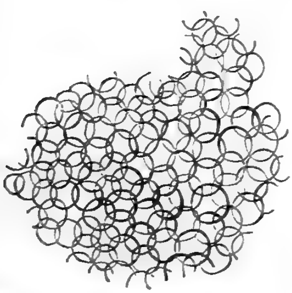
Composition of Wood.—The following Table contains the ultimate composition of several woods, cellulose, and humus:—

Wood Analysed.	Carbon.	Hydrogen.	Oxygen and Nitrogen.
Sainte Lucie ..	52·90	6·07	41·03
Ebony	52·87	6·00	41·15
Pine	51·79	6·28	41·00
Oak	50·00	6·20	43·80
Beech	49·25	6·40	44·65
Poplar	47·00	5·80	47·20
Birch	51·93	6·31	41·76
Aspen	51·02	6·28	42·70
Willow	54·03	6·56	39·41
Cellulose	44·44	6·17	49·39
Humus	57·48	4·76	37·76

The proportion of nitrogen does not exceed 1 per cent., while the ash varies from ½ to 5 per cent. in different kinds of wood. The ash consists of lime, potash, soda, oxides of iron and manganese, in combination with carbonic acid, sulphur, sulphuric acid, phosphorus, or phosphoric acid. Many of the bases exist in the sap, in combination with organic acids. The silica appears to exist in an uncombined state in the juices of the plant, and the sulphur and phosphorus must be traced to the albuminous constituents of the latter.

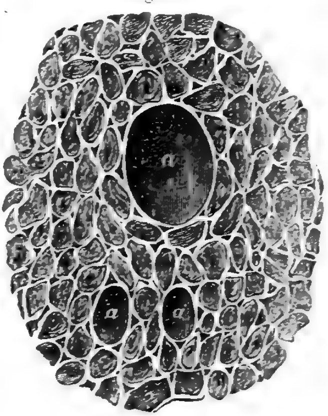
APPEARANCE OF STRUCTURE OF WOOD. DECAY OF WOOD.—The accompanying fig. 1 gives an idea of the cellular tissue, properly so called; and fig. 2 the appearance presented by the sides of the cells incrusted with the substance above named. The black spaces are the canals which still remain in the cells; some of the former, *a*, are larger, and appear to be intended for the circulation of the sap. As the wood grows by annual

Fig. 1.



Cellular tissue.

Fig. 2.



Sides of the cells.

concentric layers, the central ones are older than the external layers, and their cells are much more incrusted with ligneous matter than the latter. The central layers of the tree constituting the *heart* are therefore firmer and harder than the outer layers forming the *sap-wood*, and they are also less liable to change, as they contain less sap and albuminous matter, which are the principal agents in the decay and rotting of wood.

Among all the substances entering into the composition of plants, the cellular tissue is distinguished by its great power of resistance against the action of chemical agents; but a high temperature and the free admission of air hasten the period when decay commences.

The nature of this decay, or *eremacausis*, of timber depends, of course, on the conditions under which it takes place, and which vary accordingly, whether air and moisture are present or absent, and, thirdly, when the wood is covered with water. It is materially promoted and accelerated by the fermentation induced by air and moisture at an elevated temperature, among the saccharine and allied bodies, which are converted into acetic acid, carbonic acid, &c. This leads to the putrefaction of the azotised matter, while the wood becomes covered with cryptogamic plants, and is at length changed into a brown or black substance called *mould* or *humus*. Hence, wood of a more recent formation undergoes the conversion most rapidly, because its canals, being less incrusted with the ligneous compounds, contain more sap, and consequently more albuminous or azotised matter.

CHEMICAL CHARACTER OF DECAY. — An analysis of this humus at once explains the chemical nature of the change which the wood has undergone, which may be represented by the following formula :—

	C.	H.	O.	C.	H.	O.
Composition of oak wood	36	22	22			
Oxygen absorbed from the air			4			
				36	22	26
Products.						
Humus left behind	34	18	18			
Four atoms of water		4	4			
Two ditto carbonic acid	2	0	4			
				36	22	26

It is, therefore, a process of slow but true combustion, by which the proportion of carbon continually increases in the residual product up to that point when the affinity of the carbon for the remaining hydrogen balances that of the oxygen.

INSECT FOOD.—Further, it is the albuminous azotised matter in the sap which serves as nourishment to the various insects which occasion such destruction in timber.

OBJECTS TO BE ACCOMPLISHED.—The principal cause of the eremacausis and destruction of timber being due to the presence of azotised matters existing in a soluble state in the sap, it is clear either that these soluble matters ought to be removed, or that the proper agents to employ for the preservation of the wood ought to be those which secure the *soluble* matter from decay by forming insoluble compounds with them, and rendering them unfit for the food of animals.

As the first method is impracticable, the problem resolves itself into the employment of suitable antiseptic materials, and the use of such mechanical means as will enable the material to penetrate into the interior of the cells, fibres, and vessels, as well as the interstices which separate them.

The objects sought to be accomplished really embrace these three points:—

1. To protect the wood against wet and dry rot;
2. To increase its durability;
3. To reduce its inflammable and combustible character to a minimum;

which have accordingly become the aim of numerous ingenious patentees, who have employed a great variety of means and materials to accomplish their task.

Classification of the Processes.—These several different plans and substances may be classified as follows:—

I. The immersion and soaking of the wood in the preservative liquid, as in Kyan's patent.

II. The expulsion of the air by the application of the preservative liquid at a high temperature and allowing the whole to cool, thereby creating a vacuum in the pores of the wood, while the atmospheric pressure forces in the contents of the liquid, as in the process of Champy.

III. The exhaustion of the air and moisture and admitting or forcing in the preservative material in a gaseous form, as suggested by Moll, Bethell, Laing, and others.

IV. The exhaustion of the air and then forcing the preservative liquid into the pores of the wood in a close vessel under pressure, as in the processes of Payne, Bréant, Bethell, and others.

V. By allowing the preservative fluid to ascend along with the sap in the living tree, as proposed by Boucherie.
Or by saturating the felled or sawn timber by ascension, by the action of the capillary force, as in the patents of Boucherie, Uzielli, Newton, and Le Gros.

VI. By forcing out the sap by the pressure of the preservative liquid confined in a water-tight bag at the upper end, as suggested by Uzielli.

VII. By compression with or without the employment of any preservative material.

VIII. By combining the albuminous principles with some poisonous, metallic, or antiseptic material, as in the patents of Kyan, Burnett, Bethell, Le Gros, Boucherie, and others.

IX. By filling up the pores of the timber with solid substances, as in the patents of Treffry, Fons, Payne, Delafosse, Ransome, Assanti, and others.

X. By employing saline solutions.

XI. By puncturing the timber and filling the holes with solid preservative materials, as suggested by Kemp.
XII. By carbonizing the surface.
XIII. By the use of external applications or coatings.

History.—The first attempts to preserve timber from decay consisted in applying fatty and resinous substances externally, in order to protect the surface from the action of the atmosphere, which either induced fermentation or conveyed those insects which were equally destructive.

These plans are all more or less defective, as the application or external coating peels off, and at all events proves no protection against the fermentation, which commences sooner or later in the interior of the timber. It is stated, however, that a coating of hydraulic lime has been more successful.

The first patent secured in this country dates as far back as 1728, but no further steps appear to have been taken in this direction until upwards of a century afterwards, when Mr. Kyan in 1832 introduced his process of soaking or boiling timber in a solution of corrosive sublimate, which patent, with some modifications, is still extensively employed.

Materials proposed or tried.—During the interval which has elapsed, a great variety of chemical agents have been suggested or tried, of which the following is a list:—

Bichloride mercury.
Chloride of tin.
„ manganese.
„ zinc.
Sulphate copper.
„ iron.
„ zinc.
Nitrate iron.
Pyrolignate ditto.
Acetate lead.
Sulphate soda.
Manganate and permanganate ditto.
Carbonate ditto.
Silicate ditto.
Muriate ditto.
Phosphate ditto.
„ ammonia.
Nitrate potash.
Carbonate ditto.
Sulphate lime.
„ magnesia.
„ barytes.
Carbonate ditto.
Bicarbonate lime.
Alum.
Caustic lime.
Sulphuric acid.
Sulphurous ditto.
Arsenious ditto.
Pyroligneous ditto.
Tar and its products.
Tannin.
Tannin and gelatine.
Gutta percha.
Oils, wax, tallow.
Resin, &c.

Mechanical Operations.

Class I. *Immersion.*—The slowness with which even the most mobile liquid penetrates wood is a serious objection to any plan of simple immersion or soaking, such as that proposed by Kyan,

for Duhamel has proved that the smallest pieces of wood do not cease to imbibe the liquid after being immersed for six months.

CLASS II. *Heated Liquid.*—Champy's process is an improvement on the previous plan, and in some cases might even now be advantageously employed, as, for example, in preparing timber for fences for railways and agricultural purposes. Champy plunges the still humid wood into fat heated to 392°, but any liquid of a preservative character, whose boiling point is higher than that of water, as oils, resin, tar, &c., may be substituted. During the immersion the hygroscopic water is converted into vapour and expelled, driving out the air and gas in the tissue. On cooling, the atmospheric pressure forces the preservative material into the vacuum thus formed in the pores of the wood. Light woods, such as pines, firs, poplars, &c., have been increased in weight by this process from 50 to 60 per cent., and have proved remarkably sound for years, especially in chemical manufactories, where the acid vapours act more rapidly than ordinary atmospheric agents.

CLASS III. *Gaseous Materials.*—Another plan, to which I am inclined to attach great value, was first suggested by a German, Moll. He exposes wood in a close chamber into which he forces steam, rarefying the air, causing the gas contained in the pores to escape, and then introduces creosote in the form of vapour. Mr. Bethell employs a similar plan in one of his more recent patents, and Laing substitutes sulphurous acid gas for the creosote vapour. When the difficulty of driving a liquid body to the centre of large balks of timber is considered, it is obvious that great advantage would be gained by substituting a gaseous substance.

It has occurred to me, that by constructing an apparatus which could be maintained at a high temperature while filled with timber, exhausting the gases by mechanical means, and then forcing in the vapour of coal tar in process of distillation, a more perfect saturation of the timber would be effected than is even accomplished in the ordinary apparatus as improved by Boucherie.

CLASS IV. *Pressure in Close Vessels.*—Monsieur Bréant first suggested the advantage of employing pressure to force the preservative liquid into the pores of wood, and this idea was carried into practice by Payne and Bethell. Their plan, and that now in common use, consists of a wrought-iron cylinder firmly secured to its seat, in a horizontal position, with one end open, which can be closed by a lid. The cylinder is fitted with suitable arrangements for heating the contents by steam, exhausting the products, and then forcing in the preservative liquid by means

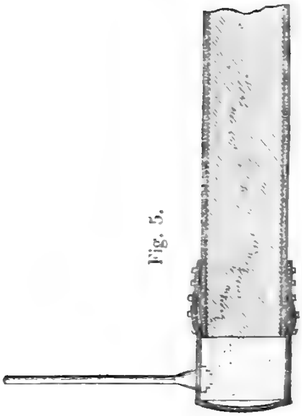


Fig. 5.

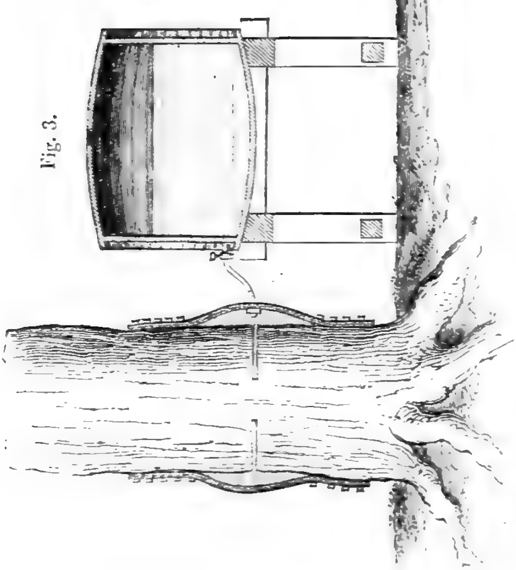


Fig. 3.

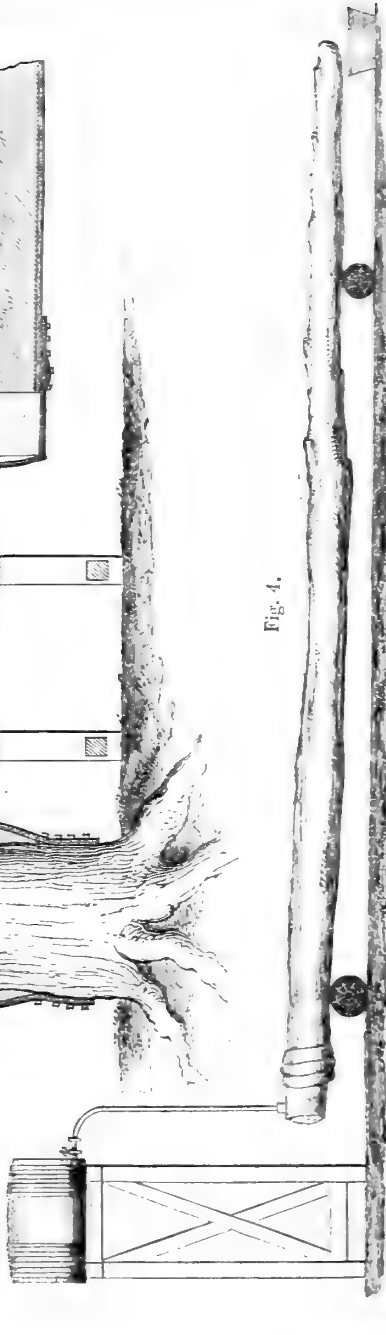


Fig. 4.

of a pump under powerful pressure. After a certain time, which is regulated by the kind of timber, the amount of pressure, and the degree of penetration required, the liquid is drawn off by means of a cock, and the contents of the cylinder are withdrawn.

The stationary character of this apparatus leads to considerable expense, as the timber must often be conveyed to and from great distances to the locality where the cylinder is fixed. This objection has been overcome by Armstrong, who has patented an improved arrangement for mounting the vessels and apparatus on a carriage and wheels for running on railways and common roads, whereby they are rendered portable and readily moved to places where the timber is lying.

CLASS V. *Capillary Action.*—Another step in advance was taken by M. Boucherie (where the circumstances admit of the adoption of his plan), who renders the natural circulation of the tree available for the admission of the preservative liquid into trees still standing or recently felled. It has been found, however, that while the liquid easily penetrates the more porous pith-wood, it seldom reaches the heart or centre portions. Certain irregularities in the penetration obtained by this method, when assisted by sawing in a proper direction, produce a beautiful appearance of a veined and marbled character. The application of this process is simple; two incisions are made near each other at the base of the tree, and covered with a water-tight cloth band, which is supplied with the preservative liquid from a small cask. (Fig. 3.) The ascent of the liquid is very rapid.

A somewhat similar plan consists in placing a tree recently felled in nearly a horizontal position, and covering its larger extremity with an impermeable sack, which is retained in its position on a collar made of clay, by means of a strong ligature or band. (Fig. 4.) The preservative liquid is conveyed to this sack by a pipe from a cask at a higher elevation, and it forces out the sap in the timber, filling the open channels as it is carried forward. In some species of wood the passage of certain liquids does not occupy more than a few minutes, as in the oak; while in pines and firs the woody fibre, in the form of long tubes, allows a much more regular infiltration of the liquid.

M. Boucherie has modified this plan in the following way:—he takes, for example, a block of timber twice as long as an ordinary railway-sleeper, and saws it down the middle to within an inch or so of the opposite side, then gently raises the upper part of the block by a wedge; the slit opens, when he inserts a piece of rope dipped in tar: the block is now allowed to resume its position, when the two sides of the slit approach and firmly grasp the tarred rope. An auger-hole is then made

through the upper surface into the space left by the slit, into which a tube is inserted for conveying the liquid, which, by degrees, insinuates itself through the whole mass of the wood.

M. Perrin has further modified the application of the same principle by fitting on to the end of the trunk a cast-iron cylinder, in which he rapidly forms a vacuum by igniting a piece of tow steeped in naphtha. The other end of the trunk being immersed in the preservative liquid, the atmospheric pressure forces it through the whole length, in one or more similar operations.

Bethell employs the same principle, in this manner:—he places the wood in an upright position in an air-tight tank nearly filled with the solution, and then exhausts the air, so as to allow the preservative liquid to fill the pores; or he substitutes a waterproof bag attached to one end of the wood, and forces the liquid through the wood by some artificial pressure.

Uzielli, Newton, and Le Gros, as well as Bethell, simply place the lower end of the tree (felled when the sap is rising, and after the bark has been removed), in their different solutions, and allow the liquid to ascend by capillary action.

Renard differs from the preceding, in placing one end of the wood in a trough containing his solution, and attaching a plate by a leather washer at a little distance from the other end. In this plate there is a tube fixed in connection with an apparatus, in which a vacuum can be produced, thus bringing the atmospheric pressure into operation.

Class VI. *Penetration by Descent.*—Úzielli, in another patent, recommends that the waterproof bag or sack should be applied at the upper end of the tree or timber, and he employs the pressure of the preservative liquid to force out the sap at the lower end.

Drying Wood.—In many of the preceding plans it is recommended that the timber should be dried before and after impregnation with the various preservative liquids. A very effectual method of rapidly accomplishing this object has been patented by Barlow, which in some measure may be classified here. He attaches a metal plate by screws to the end of the piece of timber, and packs the edges by a ring of vulcanized india-rubber. (Fig. 5.) He forces air into the intervening space, which expels the sap or preservative liquid and dries the timber; or he exhausts the air, and the atmospheric pressure produces the same effect in a contrary direction.

In concluding this part of the subject I may refer to the last and most complete mechanical arrangements of the late M. Boucherie, which embrace many of the principles ex-

plained above, and which will be found fully described in the Appendix.

Class VII. *Compression.*—A very different result is proposed to be accomplished by mechanical means by Billington, who employs suitable machinery to compress and consolidate the fibres of the wood, rendering it non-absorbent of moisture, and he dispenses with the use of creosote and all other preservative liquids.

Sievier, on the other hand, first saturates the timber with any of the usual materials, and then submits it to powerful pressure. He states that the previous impregnation increases the compactness, and renders the wood more durable.

Chemical Agents.

Class VIII. *Insoluble Albuminous Compound.*—Having described the various mechanical means employed to fill the pores of wood with the different chemical substances which have been suggested, I must now briefly review these agents, and in the first class will be found those which act upon the albuminous matters. These chemical agents have generally a strong affinity for these azotised compounds, and when combined with them they become insoluble, inert, and not susceptible of those chemical changes which ultimately lead to the destruction of the ligneous fibre.

Tannin.—Among the most obvious, but not the first which was used, is tannin, patented by Newton so late as 1840. It acts in the same manner as when employed in the tanning of skins. The long duration of oak (in the sap of which it exists) under water, as well as the preservation of fishermen's nets, are due to its action.

Tar Creosote, or Dead Oil.—Next in natural order come tar and all its derivatives, the value of which has long been recognised by the marine of all countries, but the first time they were employed for the preservation of railway sleepers only dates from Bethell's patent. They act in a similar manner to tannin, and are now generally acknowledged to be the most suitable material for this purpose.

Corrosive Sublimate.—Then follow all the metallic compounds, among which the first employed was corrosive sublimate, or the bichloride of mercury, which formed the subject of Kyan's patent in 1832, and which had long been successfully used for the preservation of anatomical preparations. The high price, and the danger to which the workmen are exposed by its absorption, are objections which have weighed against its general introduction.

Chloride of Zinc.—The chloride of zinc, patented by Burnett

in 1838, has been more generally used, for it possesses the great collateral advantage of being a disinfecting agent, for which purpose it is now very extensively employed in France.

Chloride of Manganese.—Le Gros has substituted the waste acid chloride of manganese, which runs from the stills of the manufacturers of bleaching-powder, and he neutralizes the excess of acid by oxide of zinc, which precipitates the ferruginous matters. This double chloride of manganese and zinc ought to be an excellent compound, but I do not know whether it has been much employed.

Sulphate of Copper. Pyrolignate of Iron.—The sulphate of copper appears to be in fashion at the present time, having been introduced by Boucherie, in connection with his new apparatus. I find it first named in the patent list, by Margary, in 1837. Boucherie was at first inclined to give the preference to the crude pyrolignate of iron, which he says combines many advantages, as its oxide forms stable compounds with nearly all organic substances, its acid being without corrosive action and volatile, while it contains the largest quantity of creosote which an aqueous solution can dissolve.

Sulphates of Iron and Zinc.—The use of sulphate of iron was also proposed by Bethell in his patent of 1838, and in some situations, as in copperas beds, its preservative action has been strongly shown; but it has been objected that it will destroy wood by the liberation of its acid, either under the influence of oxidation, or the combination of its oxide with the organic substances. This objection does not hold góod against the sulphates of copper and zinc, and which objection M. Bréant has attempted to obviate in the case of any metallic sulphate, by introducing linseed-oil into the wood, previously injected with these salts.

Acetate of Lead.—Acetate of lead is also an excellent material, as its oxide forms insoluble and non-putrescent compounds with numerous organic substances, while its acid is volatile and not corrosive. The crude sugar of lead would also possess the same advantages as the pyrolignate of iron, in containing a large proportion of creosote.

Arsenious Acid.—Similar in its action to the preceding bodies is white arsenic, or arsenious acid, the use of which was patented by Verner in 1849, and by Romaine in 1853, who employs a boiling liquid of oil and gas-tar, with cream of lime, and suggests the addition of arsenic to protect the wood against the attack of the white ant in the East and West Indies. The great danger, however, which attends its application is at once fatal to its general use.

Class IX. *Filling the pores of the Wood.*—This division of chemical compounds embraces another object, namely, the filling

of the pores of the wood with a solid substance, rendering the timber more rigid and suitable for such purposes as railway-sleepers. In some of these processes two solid bodies are formed, while in others one of the resulting compounds is soluble.

Oxides of Tin and Copper.—The first patent secured in which this principle is recognised is that of Treffry in 1838, who only soaked his wood in soluble salts of tin and copper, and precipitated the metallic base by means of an alkali or alkaline earth.

Sulphuret of Barium and Sulphate of Iron.—Then followed the patents of Payne in 1841 and 1846, whose name is generally associated with this principle, and who employed pressure so that the decomposition was effected in the interior of the wood, and the object more effectually accomplished than by the previous patentee. M. Wattien adopted this principle in France, employing for his first liquid a solution containing 5 per cent. of sulphuret of barium, and following this with another liquid containing 5 per cent. of sulphate of iron, both under a pressure of 10 atmospheres. A double decomposition takes place in the pores and vessels of the ligneous tissue, by which two insoluble compounds were formed, namely, sulphuret of iron and sulphate of barytes, while an excess of sulphuret of barium remained to repel the attack of insects, the action of fermenting fluids, and the generation of mould. This mode of carrying out Payne's process communicates great rigidity and density to the sleeper.

Various modifications of metallic Salts, &c.—Halden has patented the use of sulphuret of calcium and chloride of zinc; Jackson the use of sulphate of zinc and phosphate of ammonia; and Kemp the use of sulphuret of barium and sulphate of copper.

Soluble Silica and Acids.—Ransome proposed, in 1845, to imitate the petrifactive process of nature, by impregnating the timber with a solution of silica, and then immersing it in an acid or saline solution, so as to render the silica *insoluble.* He has since then suggested the use of chloride of calcium, or a solution of chloride or other soluble acid, salt of iron, copper, zinc, lead, or barium.

Gutta Percha and Bisulphuret of Carbon.—A modification of this principle has been proposed by Assanti, who dissolves gutta percha in bisulphuret of carbon, which he forces into the timber, and then expels the volatile solvent, leaving the pores of the wood filled with gutta percha.

Class X. *Saline Solutions. Common Salt.*—Of this class of chemical agents, common or sea-salt may be taken as a type, which is so universally employed in preserving meat, fish, skins,

&c. In salt-mines, pieces of oak and fir have been observed covered with salt water, which have been preserved for ages without the least alteration. It is also stated that the Americans employ it for preserving the outside planking of their ships.

Of course, in localities where there is an excess of water, the salt may be entirely removed, and thus leave the woody tissues exposed; and in localities alternately wet and very dry, sea-salt comes to the surface as an efflorescence.

Chloride of Calcium.—Chloride of calcium acts in the same manner, but it offers some other advantages, as, for example, where timber is used in dry places it preserves the wood from alteration by its hygroscopic property, and enables it to retain its elasticity.

Sulphate of Soda.—Similar remarks apply to the alkaline sulphates and nitrate of potash, but the sulphate of soda has an action the very reverse of chloride of calcium, for it possesses the property of drying wood with great rapidity.

All these saline substances can only act by mingling with the sap; and timber, so to speak, thus *salted*, is evidently protected from decay, and Boucherie attributes to the alkaline chlorides a preservative action little short of pyrolignate of iron.

Class XI. *Puncturing Timber, &c.*—The previous processes all depend upon the penetration of the preservative material in a state of solution, but there is one patent by Kemp, who, in addition to the means already noticed, punctures the wood by the spike of a puncturing roller, and fills the perforations with a solid mixture of arseniate of copper, carbonate of barytes, and red lead.

Class XII. *Charring the Surface.*—Instead of applying any foreign external agent to protect the timber, a patentee, of the name of Ferguson, has proposed to convert the outer layers of the wood into charcoal, by passing large heated iron rollers over the surface. This principle of charring wood has long been in use when inserting timber posts and poles in the ground; but while the charred portion resists the action, and to a certain extent protects the inner layers, yet after the lapse of some time the external coating of charcoal alone remains in a sound condition.

Class XIII. *External Coatings. Wax and Fat.*—This division of chemical and other agents embraces all those proposals which mainly rely for protection on external applications, and among which may be noticed all the oils, fats, and resins whose preservative action is chiefly mechanical. It is said that a mixture of melted wax and fat may be introduced into wood to the extent of even 60 per cent., and for certain purposes is most beneficial, as it prevents the wood from twisting and cracking.

Bethell's Paint.—Mr. Bethell, in his patent of 1853, after charging the wood with a soluble salt of zinc or copper, runs a truck-load of the sleepers into a drying-house, through which all the smoke and gaseous products evolved during the combustion of the fuel are passed, and after being cooled down he paints them with tar, or melted pitch, or bitumen, or rosin, or any description of varnish, or gutta percha dissolved in any spirit or oil, or with any material which will make a water-tight covering to the wood.

Sulphuret of Antimony and Copper in Varnish.—Key and Guibert employ a pigment formed of 10 parts of sulphuret of copper, 2 parts of sulphuret of antimony, and 5 to 30 parts of the best varnish, with which they paint the surface of the wood.

Asphalte.—Westwood and Baillie apply a preparatory coating of black varnish and afterwards an asphalte or bituminous composition, by which they insure the adhesion of the latter with increased tenacity.

Greenshields modifies this plan by previously soaking the timber in a solution of alum and common salt, and adds tallow-elaine to the asphalte.

Vitreous Compounds.—Madame Boulard proposes to employ a peculiar vitreous composition with different colouring matters and applied in the usual way.

Glue and Tannin.—Clark states that he partially impregnates, while coating the timber by applying a solution of gelatine or glue, and by then soaking it, after being dried, in a solution of tannin, forms an artificial leather in the pores and on the surface of the wood.

Electro-coating of Metal.—A modification of this use of external agents has been patented by the Messrs. Oudry, who clean the timber and cover it with a slight layer of varnish or fatty body; they then drive into the wood barbed copper pegs at different points and expose the whole to an electro-chemical bath, by which means they succeed in depositing the metal uniformly over all the surface. They have since modified the plan by first coating the timber with any isolating material, which assists in preserving and rendering it waterproof.

Staining and Ornamenting Wood.

Staining Wood.—The staining of wood has been most successfully accomplished by MM. Renard and Perrin. These gentlemen introduced into wood all the dyes and preparations of alum which have been applied to cloth. Madder, cudbear, campeachy, or Brazil wood, give different shades of red or violet; madder, indigo, or campeachy, with the addition of nitrate of

copper, produce blue colours; acetate of copper yields a green colour; the successive action of nutgalls and sulphate of iron gives a black colour; and lastly, by treating wood, first with a weak solution of soda, then with a solution of bleaching-powder, after this with very dilute muriatic acid, and finally with pure water, the wood is bleached and becomes perfectly white.

Ornamenting Wood.—Signor Muratori, in addition to colouring wood, has adopted the following plan for ornamenting it:—He first paints the surface with a preparation of Palermo white, and before it is dry he sprinkles over the surface pulverized coloured wool and Dutch metal; he then produces a variety of patterns by a carved printing-block in the ordinary manner.

Process for rendering Wood non-inflammable.

In concluding this review of what has been proposed for the preservation of timber, I may remark that different patentees claim for their suggestions the additional advantage of rendering the wood non-inflammable: this object is doubtless to some extent accomplished, for some of the compounds of boron and phosphorus possess this property in a striking degree.

Maugham has recently patented (1856) the use of phosphate of ammonia for this purpose. He first boils the timber, and then exposes it to steam pressure to expel the air, &c.: the wood is then dried and impregnated with a solution containing 9600 grs. of this salt per gallon.

Gateshead Experiments.

General Arrangements.—Such was the position of this important subject when I undertook its investigation; and having occupied some time in deciding upon the most convenient form to be adopted in the apparatus, so as to anticipate as far as possible the probable direction in which the experiments might lead, I ultimately erected a cylinder in one of the sheds at the Gateshead Works, sufficiently large to hold four sleepers. In the general arrangements the apparatus resembled that employed at the North Docks at Sunderland, and during the course of my experiments I was ably assisted by Mr. Marreco.

After experimenting upon several sleepers with various chemical preparations, I found that the preservative liquids rarely penetrated to the centre of the timber, and I then sought to devise such alterations of the plans as would overcome this difficulty; with the valuable aid of Mr. Reed this object was successfully accomplished.

Alteration of Cylinder.—The nature of this modification will be easily understood. Each end of the cylinder was made

a moveable lid; one lid was perforated for two screws, with a piece of iron at the end to prevent the screws penetrating the wood. I only used one screw, but I have shown how two or more screws might be added to a cylinder so as to operate upon more than one sleeper at a time. The other lid was cast with an opening nearly corresponding in size with the end of the sleeper. The inside edge of this opening was cast with a ledge projecting about ½ an inch above the surface. The wood being placed in position, the lids were screwed on to the cylinder, and the sleeper forced tight against the opening in the one lid by means of the screws in the opposite lid. The cast-iron ledge penetrated the wood to the depth of ½ an inch, and thus prevented the liquid in the cylinder from escaping between the lid and end of the sleeper. After exposing the sleeper to the action of the liquid under less than the ordinary pressure, a fine mist gradually appeared over the whole surface of the open end, showing how complete had been the penetration. An examination of the interior of different sleepers proved that this mode of operating was most effectual, and much more rapid than that by the old method. After I had this plan in operation for some time, I discovered that M. Boucherie had anticipated us in one of his recent patents.

In order to avoid any prepossession in favour of any particular preservative liquid, I was careful not to read any of the specifications until the experiments were completed, and I now give an outline of the various materials employed, until I adopted that substance which will form the basis of my recommendation at the conclusion of this Report.

It will be noticed that I have tried some of the materials in the simple form as generally adopted, and converted others into a solid state by subsequent decomposition as recommended by Payne and others.

Materials employed.—I first employed dead oil or creosote alone, and subsequently diluted with varying proportions of water; also wood tar heated to the boiling point of water, &c.

I then used chloride of lead in solution, and afterwards dried several of the sleepers at a low heat. One or more of these sleepers were submitted to the action of one of the following solutions, viz.:—

Lime water,
Sulphuretted hydrogen,
Weak sulphuric acid,
Arsenious acid.

The next batch of sleepers were treated with lime water, and some of these sleepers were submitted to the following chemical compounds in solution, viz.:—

Silicate of soda,
Sulphate of iron.

Another series of sleepers were first saturated with a solution of green copperas, or sulphate of iron, and then treated with solutions of materials named below :—

Shumac,
Arsenious acid,
Gas water.

I further tried a solution of chloride of barium alone, and afterwards decomposed it in some of the sleepers, by means of an alkaline sulphate.

Another set of sleepers were impregnated with a solution of chloride of calcium, which were further treated with solutions of

Carbonate of soda,
Sulphate of soda.

I also tried arsenious acid alone in solution, and combined it afterwards, in some of the same sleepers, with sulphur, which I employed in solution in the form of sulphuretted hydrogen.

I likewise tried a solution of glue, which I endeavoured to render insoluble in the pores of the wood by the subsequent action of shumac.

I also treated some sleepers with a solution of shumac.

Old Sleepers.—When I had reached this point, and during a journey to York, I noticed the piles of old or waste sleepers accumulated at different points along the line; and it occurred to me that it might be possible to convert them to some useful purpose. On returning to Newcastle, instead of continuing the series of experiments, in which I had intended to try various preparations of manganese, bi-carbonate of lime, &c., I made an examination of some old sleepers.

The result of that examination led to the adoption of that process which I have now to detail, and in prosecuting which I had the benefit of the excellent advice of Mr. Browell.

Considerations in the Choice of Materials.—In all the experiments related above, I was guided in the choice of my materials by the considerations of their effect in increasing the durability of the timber, the facilities they offered in their application, the first cost in some measure dependent on the extent of their consumption, and, lastly, on the market for a present and future supply.

I believe it can scarcely be affirmed of any of these substances, that they meet all these conditions, although many of them are, at present, what may be termed waste manufacturing products.

RAW MATERIAL FOR CREOSOTE, &c.—The contrary, however, is the striking characteristic of that material which I now propose. The beneficial action of creosote is now universally recognised, the mode and facility of its application is well understood, and there is practically no limit to the present and future source of supply, as well as economy, in the waste old sleepers and timber of your extensive railway system.

PROCESS OF CONVERSION.—The process of converting this old timber to this useful purpose consists in subjecting it to dry distillation in suitable close furnaces or retorts, and condensing the volatile liquid products by an arrangement similar to that in use at gas-works. The further details will be best given in the words of the specification of the patent for this improvement.

"In order to obtain tar and other products from old or waste railway sleepers or bearers, we proceed as follows:—

"We remove all adhering dirt or other foreign matters from the old or waste railway wood, sleepers, or bearers, before subjecting them to distillation. This waste timber may be used whole, or it may be first cut into small faggots, and we prefer that it should be air-dried for some time previous to distillation. The clean and dry old and waste timber, either whole or cut into smaller blocks, we submit to dry distillation, and for this purpose we prefer to employ the arrangements and apparatus now in common use for making coal gas, merely washing the gas with a weak solution of soda before passing it into the lime purifiers. This gas, which is obtained in addition to the tar and other products, is suitable for use for illuminating purposes.

"The retorts are heated up to a cherry or bright red heat, and we find the higher the temperature the better for our general purposes. We charge each retort with about one hundredweight of the timber prepared as above described. We drive the distillation as rapidly as possible, and we work off the charge in from two to three hours according to the kind and state of the timber. The charcoal is withdrawn, and the fire extinguished by water or charcoal powder. The gaseous products require more lime for purification than coal-gas, but they possess the great advantage of being free from sulphur compounds, and may be used either alone or mixed with ordinary coal-gas. The liquid products of the distillation, which are arrested in the hydraulic main, principally consist of the tar and acetic acid, and these may be separated and treated in the usual manner, in which case the tar, when distilled, will furnish the compound known under the name of dead oil, which may be employed at once for the preservation of new sleepers and bearers in the ordinary manner. But, instead of distilling the tar, for the purpose of obtaining the dead oil, we prefer, according to the second part of our intention, to mix one of the following saline solutions with it in about equal volumes, viz., a solution of caustic soda of about 1·13 specific gravity, or the liquor known in the alkali trade under the term of red liquor, with a specific gravity of about 1·30. We heat these mixed fluids to a temperature of from

90 degrees to 100 degrees of Fahrenheit, and we force this warm solution into the cylinder containing the timber, with the usual precautions.

"By mixing the tar with these solvents we render it perfectly fluid and suitable for use in preserving timber, whereas, heretofore, in order to obtain a preserving liquid of sufficient fluidity to be successfully employed for this purpose, it has been necessary to distil the tar, and so separate from it bodies which, although they have considerable preservative properties, render the tar too thick for use. Or, instead of separating the acetic acid portion of the liquid products, where the acetic acid is present in comparatively small quantities, we neutralize the acid by means of carbonate of soda, or otherwise, and we dissolve in 1 gallon of the liquid about 1 lb. of caustic soda, or 2 lbs. of red liquor salt, and mix it gallon for gallon with the tar, warming up the mixed liquors to about 90 degrees to 100 degrees of Fahrenheit, and proceeding as before. In this way we render useful the proportion of preserving material which would otherwise be lost in the acetic acid liquid.

"In all these different methods the temperature may be varied considerably without affecting the result; and when it is not an object to collect the gas in distilling the waste timber, a lower heat and slower distillation will increase the production of the liquid product.

"We would remark that, when sleepers or bearers are distilled which have originally been submitted to the creosoting process, we obtain, in addition to, and mixed with the tar formed by the distillation of the wood, the dead oil originally used in the preparation."

Results of Distillation.—I submitted some of the waste sleepers to distillation at Gateshead, and quote some of the results by way of illustration:—

1. A decayed Scotch fir sleeper, when distilled slowly, at a moderate heat, gave 25·88 per cent. charcoal, and 58·82 per cent. tar and pyroligneous acid: distilled rapidly at a high heat, I obtained 17·30 per cent. charcoal, and 61·72 per cent. tar and pyroligneous acid.

2. A larch sleeper, in a state of very great decay, slowly distilled, at a low heat, furnished 23·00 per cent. charcoal, and 58·77 per cent. tar and pyroligneous acid; and rapidly distilled at a high heat, the produce was 17·31 per cent. charcoal, and 62·78 per cent. tar and pyroligneous acid.

3. While an elm sleeper, comparatively sound, treated in a similar manner, gave—

	Slow firing.	Quick firing.
Charcoal	26·14	13·49
Tar and pyroligneous acid	51·80	66·16

These sleepers were taken at random from a heap lying near the line, and they had not been creosoted.

Products of Distillation. *Gas.*—When rapidly distilled at a high heat and in small pieces, the proportion of gas is much

increased at the expense of the liquid and solid products. In fact, advantage is taken of this circumstance at Munich and other towns on the Continent, which are lighted by wood gas.

Tar.—The tar obtained from these distillations amounted to about 10 per cent. on an average, and the crude pyroligneous acid measured from 4 to 5 gallons per cwt. of timber.

The tar obtained by slow distillation is sufficiently fluid at 110° Fahrenheit to be employed at once as a preservative material, but its fluidity is increased, as well as its preservative power, by the addition of the red liquor as detailed above in the specification.

Pyroligneous Acid.—The pyroligneous acid, which contains so much creosote, and has so long been known for its remarkable antiseptic power, may be neutralized by lime, and then worked up with the prepared tar. By this treatment each cwt. of wood will produce upwards of 5 gallons of a mobile and highly preservative liquid.

I have tried this liquid at Gateshead with several sleepers with great success, and I have kept some by me, for several months, without its losing its homogeneity.

Charcoal.—The charcoal left behind is of excellent quality, not, of course, so hard as that obtained from sound timber; but when it is borne in mind that the principal seat of the decay in sleepers is really that portion under the chair, the proportion of hard charcoal is very large.

Application of Products.—The purposes for which charcoal is used are so well known that I need not call attention to them; but there is one which I must not overlook. The conversion of the external surface of the rails and other iron on the line into steel has become one of the necessities of the railway system, and in this process there is a large consumption of charcoal. As soon as the application of this process becomes general, the demand for charcoal, an article of such limited production in this country, must necessarily soon very materially enhance its price; but, by the conversion of the waste sleepers, as already described, this contingency is, as it were, more than anticipated.

Difference in the old creosoted Sleepers.—The above observations all have reference to sleepers which have not been creosoted; but, with sleepers which have been treated with dead oil, I find this valuable fact—that, on distilling them, nearly the whole of the creosote oil is recovered, in addition to that produced by the destruction of the ligneous fibre, while the charcoal left behind is much more dense and hard. In some cases I have obtained as much as 18 per cent. of tar of a very fluid character.

The use of the soda in preparing the tar for creosoting, while

rendering the liquid more available, will also improve the character of the charcoal, as in the process of steeling the rails a certain proportion of soda is necessary.

FENCES.—The above preservative liquid being so fluid, it is admirably adapted for use in creosoting the timber employed along the railway for fences. For this purpose, it only requires to be heated above the boiling point of water in an iron tank, which can be mounted on a carriage and wheels, to travel from place to place. The posts and rails, being immersed in it and allowed to cool, may then be placed upright, in a cistern containing the same liquid, to two-thirds of their length, when the impregnation will proceed very rapidly. It is obvious that the same plan might be advantageously adopted by landed proprietors, for the fences on their estates.

The adoption of this plan for preserving sleepers necessarily superseded that part of my proposal to combine the colouring or staining of timber with its preservation; but I regret this the less, because the plans which MM. Renard and Perrin have invented have had the benefit of experience, and were rewarded with a silver medal at the Great French Exhibition in 1849.

I have now the honour to recommend for adoption on your railways—

1st. That the old waste sleepers and timber should be submitted to distillation in suitable apparatus, and that the waste heat of your coke-ovens, or furnaces for steeling your rails, be employed for this purpose. The tar and pyroligneous acid and charcoal to be applied as already explained.

2ndly. That the preservative liquid be employed in the manner recommended by Champy, for the preservation of the posts and rails of your fences.

3rdly. That the wood which is now protected and ornamented by an external coating of paint, be stained and preserved by the process of MM. Renard and Perrin.

Newcastle-on-Tyne,
May, 1859.

II.—*On the best Means of applying Manure to the Land in a Liquid State.* By PETER LOVE.

IN several parts of England and Scotland the system of applying liquid-manure to the land, by an arrangement of underground pipes, has been adopted; from these pipes hydrants are brought to the surface in the centre of every four or five acres, and to these hydrants lengths of hose are attached, as the manuring ope-

ration proceeds, until the whole four or five acres are manured. Though this seems a simple and expeditious operation, yet in practice there is a vast deal of labour in unscrewing and dragging the hose over the ground, and also a great waste by unequal distribution of the manure: the wear and tear of the hose, caused by pulling it over the land, is also a large item in the annual expenses of this system; and the time lost in moving it is about equal to the time employed in applying the liquid. This is a serious waste of means where steam or animal power is used for forcing the liquid through the pipes, but where gravitation gives the pressure it is of less moment. During the dry season of the year, however, when this operation is chiefly carried on, it is of immense consequence that it should be proceeded with without stoppage, doing as much as possible in the latter part of the day, when evaporation ceases, so that before morning the earth will have drunk it up, leaving but little to be wasted next day. I was forcibly struck with the loss arising from this cause when inspecting Myremill farm, near Ayr, in the summer of 1854. At that time Mr. Kennedy was applying liquid-manure to freshly-planted cabbages, at the rate of 12,000 gallons per acre, equal to about half an inch in depth over the whole surface of the land, the land being in a very dry state, and the weather very droughty. In a few hours almost the whole was dried up, and the advantage of the large supply of water nearly lost; whereas, where the manure was applied in the evening, the loss from evaporation was but small.

Inexperienced men may imagine that it is both simple and easy to drag the hose over the land, but it should be remembered that every 16 yards in length of 2½-inch hose, and every 12 yards of 3-inch hose, full of liquid-manure, weighs a cwt. Notwithstanding these difficulties, however, the system is spreading, especially in the north. I have visited several of these farms from time to time for the last five years, and am quite satisfied that for green crops, especially Italian ryegrass and cabbages, it is profitable; the feeding power of these crops so produced being of the highest standard, and the amount of produce scarcely believable.

The land is always perfectly clean after growing Italian ryegrass for two years, during which time it will have been cut ten or twelve times, and after each cutting will have received from three to twenty thousand gallons of liquid-manure per acre; the quantity of water mixed with the manure being ruled by the dryness of the weather and soil. If the land be already saturated with water, 5000 gallons of undiluted liquid-manure should be applied; but if it be parched, and there be no chance of rain, then water should be added to make up 23,000 gallons per acre, equal to a depth of one inch, or ten hours' rain, which will be of

great advantage. As the quantity of liquid-manure depends upon the number of stock feeding, and the number of the stock upon the quantity of food produced, the crops that will produce the most rapid succession of cuttings must be the best. Italian rye-grass stands pre-eminent in this respect, and is peculiarly adapted for the purpose; indeed, the liquid-manure system hangs upon it, as it is the only grass that will give us a regular supply of highly-nutritious and profitable food for stock, without cultivation and re-sowing, and which requires no hay, straw, or other food to be given along with it.

I found on all these farms that the grain-crops did not require any manure; in fact, they were rather inclined to be over-luxuriant after Italian ryegrass used for soiling. The ryegrass is always cut before it has fully shot into ear, so that it does not absorb the grain-producing elements from the soil, but allows them to accumulate for the benefit of future crops: thus the land is left clean and full of grain-producing strength. The best crop to follow the ryegrass is early sown oats, as it is less liable than others to be injured by over-luxuriance; and is benefited by deep ploughing, which should be done on the Kentish principle, of complete inversion of the furrow-slice. After the oats wheat will be sure to be both productive and of good quality: it requires the land to be shallow-ploughed; thus the turf will be left buried, and what was the under-soil will remain exposed to atmospheric action. With the wheat clover-seed is sown and hoed in during April. This clover is to be dunged during the winter, and mown twice for hay the following summer, then ploughed shallow for wheat, after which the land is ploughed moderately deep for barley; a deeply-cultivated and highly-manured crop of turnips is next taken, and the land is then laid down for two years in Italian ryegrass. By this rotation an abundance both of grain and of beef and mutton will be produced at moderate expense for purchased manures. Close observation, and two years' experience in the liquid-manure system, have convinced me that only green crops, especially Italian rye-grass, are benefited to a paying extent by the application of liquid-manure in a dilute form; indeed, when we reflect that it is in our driest districts that the most abundant crops and best quality of grain are produced, it is evident that it is only the green crops that can give a direct return for the capital invested in liquid-manure apparatus. As the apparatus is therefore only applicable during a portion of the rotation, the great desideratum is to discover some mode of diminishing the amount of capital required for the first outlay, as well as to endeavour, by a better mode of application, to reduce the expense of distributing the manure; and if at the same time we can reduce to a minimum the wear and tear of hose, &c., still more profit will follow.

By my arrangements I accomplish all these, and at the same time simplify the system, and bring it within the grasp of the tenant-farmer.

My plan is to lay only one straight main pipe under ground, bisecting the piece to be irrigated, the branches being portable, laid on the surface parallel on either side, at sufficient intervals, and shifted from the land just ploughed up out of Italian rye-grass, to the field just laid down with Italian ryegrass. By having only the land immediately around the farmery treated in this manner for providing a supply of Italian ryegrass, the distance of haulage is greatly reduced, and the length of main pipe also. The rotation of crops would then be as follows:—1st, wheat; 2nd, turnips; 3rd, Italian ryegrass; 4th, Italian ryegrass: or 1st, turnips; 2nd, early short-straw peas; 3rd, Italian ryegrass sown the instant the peas are off in July or early in August—this would give decidedly the best chance to the ryegrass, but it would be at the loss of the difference between the value of the wheat and pea crops, the latter being more hazardous.

If, in addition to this, my distributing-machine (figs. 1 and 2) be used, which admits of a wider interval between the metallic pipes, the saving of time, manure, and power in spreading the manure over the land will be still greater. The progress of the machine is altered by change-wheels, so that any quantity can be applied, from 2000 gallons to above 23,000 per acre. The manager of the distributor swings the jet or spreader from side to side, throwing the manure over about 22 yards wide: with this width the machine will need to travel 220 yards to cover an acre. A good hydraulic engine will force 80 gallons a minute through 3-inch hose; so that to apply 3000 gallons will take 37½ minutes, and the machine must travel at the rate of only about three yards per minute, or a little more than a mile in nine hours; but as it must go twice over the ground, it must go at double that rate. One man with proper crank and handle will easily propel it over the ground, if mounted upon Boydell's rails; and the whole weight of it when starting, with all the hose full of manure upon it, will not be more than 25 cwt., while every twelve yards it progresses it will uncoil a cwt. of hose and manure: the work will be eased as it recedes from the portable hydrant and pipe, and gradually increases as it advances, coiling up the hose again; the machine is then run on to its proper position in the middle of another 22 yards, or other width determined upon, when the work progresses as before. Thus, in 37½ minutes, or under two-thirds of an hour, above 13 tons of liquid manure can be spread over an acre or any other greater or less quantity of land, the flow from the spreader being the same—viz., 80 gallons per minute, if 3-inch hose; 56 gallons, if 2½-inch

PLAN OF LOVE'S LIQUID MANURE DISTRIBUTOR.

Fig. 1.

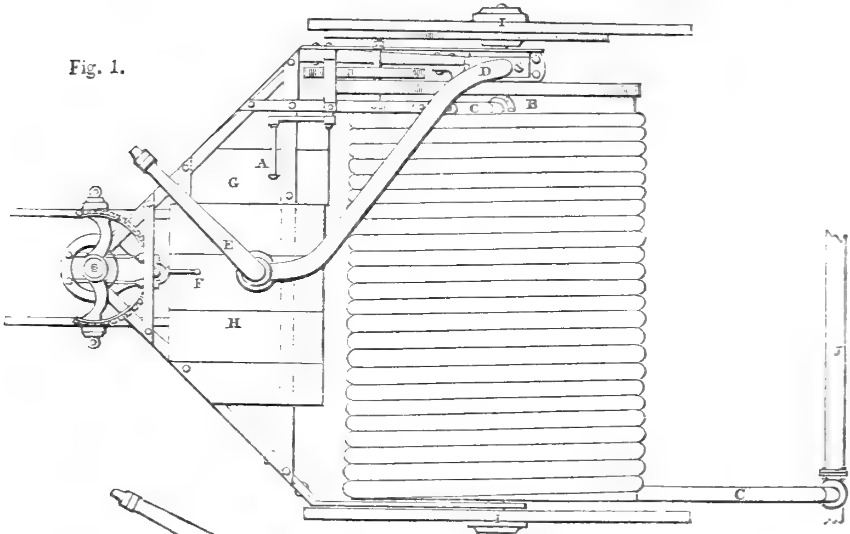


Fig. 2.

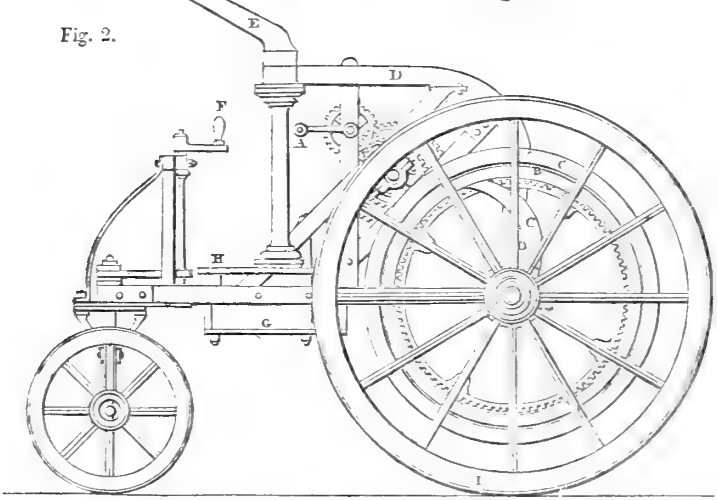


Fig. 3.

Figs. 1 and 2.

A. The handle by which the drum and whole machine are propelled.

B. The drum on which the hose is coiled.

C. The hose; one end attached to the pipe, and the other to the hollow axle through which the manure passes into

D, the pipe that delivers it to

E, the distributor or spreader, which has a horizontal joint that enables the man (by keeping it in motion to and fro) to distribute the manure evenly over about 22 yards wide, as his assistant propels the machine either way.

F. The handle by which the man steers the machine.

G. The platform on which the man who propels the machine stands.

H. The platform on which the man who works the distributor, or spreader, stands.

I, I. The principal wheels, which are fixed to the axle, but the near-side one can be allowed to be independent when turning abruptly.

Fig. 3.

J. A portable bridge to take the machine and carts, &c., over the portable pipe without injury.

K. The portable branch pipe.

2½-inch hose; and 36 gallons, if 2-inch hose; the speed the machine travels at, and the width taken in, determining the quantity applied per acre. The accompanying figures give the plan of a machine with single drum, to coil only 120 yards of hose; but there is no difficulty in making the drum double, so that more than double that quantity can be coiled up. It takes 224 yards to a ton when full of liquid manure, and this would enable the metallic portable branch pipes to be ten chains apart on the farm; but this distance can be increased or diminished to meet the shape of the farm and of its fields.

I add a series of tables giving further information. Table I. gives the gallons, cubic feet, and tons weight of liquid manure corresponding to dressings of tenths of an inch in depth over an acre of land, assuming the sp. gr. of the liquid to be 1·13: it also gives the diameter of circular tanks 10 feet deep which would hold the quantity specified:—

TABLE I.

Depth over the Surface.	Gallons.	Cubic Feet.	Tons.	Diameter of Tank. Feet.	Diameter of Tank. Inches.
·1 of an inch.	2,269	364	11·34	6	10
·2 ,,	4,538	729	22·68	9	8
·3 ,,	6,807	1093	34·	11	10
·4 ,,	9,076	1458	45·36	13	8
·5 ,,	11,345	1822	56·72	15	3
·6 ,,	13,614	2187	68·1	16	8
·7 ,,	15,883	2551	79·4	18	0
·8 ,,	18,152	2916	90·75	19	3
·9 ,,	20,421	3281	102·1	20	6
1· inch	22,690	3645	113·4	21	7

Note.—The depth of the tanks is assumed to be 10 feet from the springing of the invert or bottom arch.

Table II. shows the cost of tanks of different sizes in cubic yards of excavation, the minimum cost being 4*d.* a yard; also the quantity and cost of clay (at 1*s.* a yard) required to pack 4 inches thick behind the brick-work; and the number of bricks required to a 9-inch wall, 4-inch bottom, and 9-inch arch-cover, leaving a man-hole of 3½ feet in diameter in the middle of the arch. The cost of bricks, lime, sand, laying and staunching with clay, will be about 36*s.* per thousand bricks; but the price paid for excavation will vary with the hardness of the subsoil, and with the presence of quicksand, rock, or other impediments to its execution. The bottom should be concave, the segment of a sphere, the radius of which is equal to the diameter of the tank, and the dome or cover should be of the same shape.

There should also be a mixing-tank, where the liquid manure is mixed with guano, superphosphate of lime, nitrate of soda,

rape-dust, or any other manure necessary to bring the land up to the pitch of fertility required to enable it to be self-supporting. This tank must be at least double the size of the collecting-tank, so as to allow water for dilution to be mixed with the manures that are to be applied during the day :—

TABLE II.

Quantity in Gallons.	Depth of Tank.	Diameter of Tank.		Depth of Excavation.	Diameter of Excavation.		Cubic Yards of Excavation.	Staunching Clay in Cubic Yards.	Bricks for Walls, Dome, and Bottom; Standard Size.	Total Cost.		
	Feet.	Ft.	In.	Feet.	Ft.	In.				£.	s.	d.
2,269	10	6	10	12	9	0	28	$5\frac{2}{3}$	4,200	8	6	2
4,538	,,	9	8	,,	11	10	49	8	6,100	12	4	0
6,807	,,	11	10	,,	14	0	68	$10\frac{1}{4}$	7,900	15	17	4
9,076	,,	13	8	,,	15	10	87	$12\frac{1}{4}$	9,600	19	7	0
11,345	,,	15	3	,,	17	5	106	14	11,000	22	5	4
13,614	,,	16	8	,,	18	10	124	$15\frac{2}{3}$	12,400	25	3	6
15,883	,,	18	0	,,	20	2	140	$17\frac{1}{8}$	13,700	27	17	0
18,152	,,	19	4	,,	21	6	161	19	15,100	30	16	3
20,421	,,	20	5	,,	22	7	180	$20\frac{2}{3}$	16,500	33	15	0
22,690	,,	21	7	,,	23	9	199	22	17,900	36	13	0

Note.—The depths are measured from the spring of the bottom arch.

Twenty-five feet I consider a maximum diameter for a 9-inch wall; and it will be as little expense to construct two tanks with 9-inch walls, as one large one with 14-inch walls; but the capacity can be increased by making the tanks deeper.

The average quantity of urine evacuated daily by cattle when fed on Italian ryegrass, good turnips, or other succulent food, is about one gallon for every 5 score that the animal will weigh when fit for the butcher, after five months' feeding, and the water required to swill the solid manure into the tank will be double that quantity; therefore, taking into account the urine, solid excrement, and water used for swilling, 27 gallons a day is a fair average per head, for which tank-room must be provided. The average produce of an acre of Italian ryegrass will give a day's food to about 180 head of cattle, which, according to the preceding estimate, will yield 4800 gallons of liquid manure,—a quantity that, if applied the same evening to the same acre, will produce grass ready to cut again in from three to five weeks. Taking the longer date, we shall need 35 acres to keep up a full supply for the 180 head of cattle; and the size of the collecting-tanks required will be 138 gallons for every acre of Italian rye-grass grown. But as by this system the grass will be sure to come to the scythe every four weeks (at all events during the summer months), there will be food sufficient for a proportionally greater number of cattle, and the said tanks ought to be at least large enough to hold 175 gallons for every acre

of Italian rye-grass grown. This is on the supposition that the tanks are emptied every day; but in order to provide for the accumulation which takes place on Sundays, or during a temporary stoppage of the machinery, it is necessary to have additional tanks, which can be provided by each one, according to his own requirements, in accordance with the rule here laid down, that each day will fill a tank containing 175 times as many gallons as there are acres of Italian ryegrass grown for soiling.

The following calculations show the expense of the field-apparatus (*i.e.* pipes and hose) of this liquid-manure system. (1.) On a farm of 408 acres, where the whole field is treated as under the present system—with pipes under the whole ground, and hydrants at intervals all over it. (2.) On the same farm, where an underground main pipe is supplied with portable surface pipes, to serve for $\frac{3}{8}$ths of the surface. The other tables (3), (4), (5) are sufficiently explained by their respective headings.

1. *Estimate for* 408 *Acres under the Ordinary System.*

	£.	s.	d.
1364 yards of 5-inch main socket-pipe laid, at 5*s.* 6*d.*	375	2	0
10 tees or crosses with 4-inch arms, at 15*s.*	7	10	0
10 5-inch cocks, at 30*s.*	15	0	0
11,710 yards 4-inch socket-pipe branches, at 4*s.*	2342	0	0
90 hydrants for 3-inch hose, at 40*s.*	180	0	0
90 tees to join hydrants to 4-inch pipe, at 24*s.*	108	0	0
96 yards of India-rubber 3-inch hose, at 10*s.* 6*d.*	50	8	0
Copper branch-jet and spreader with cock complete	2	10	0
Hose-reel and carriage	6	10	0
Hydraulic engine and tank pumps	80	0	0
Total, minus the steam-engine and tanks ..	£3167	0	0

2. *Estimate for* 408 *Acres under Mr. Love's plan of Portable Branch Pipes, provided for* $\frac{3}{8}$*ths only of the Surface of the Land.*

	£.	s.	d.
1364 yards of 5-inch main socket-pipe laid, at 5*s.* 6*d.*	375	2	0
10 tees or crosses, with 4-inch arms flanged, at 17*s.*	8	10	0
10 5-inch cocks, at 30*s.*	15	0	0
4682 yards 4-inch flange pipe with bolts, India-rubber rings complete, at 5*s.* 6*d.*	1287	11	0
40 hydrants for 3-inch hose, at 40*s.*	80	0	0
40 tees to join hydrants to pipe, at 24*s.*	48	0	0
96 yards India-rubber hose, at 10*s.* 6*d.*	50	8	0
Copper branch-jet with brass cock and spreader	2	10	0
Hose, reel, and carriage	6	10	0
Hydraulic engine and tank pumps	80	0	0
	£1953	11	0
Capital saved by this plan	£1213	9	0

and at the same time the tear and wear from corrosion of the pipes while out of use is avoided. The continuous and active use keeps up sufficient friction to greatly stay the progress of corrosion in the pipes.

3. *Estimate for* 102 *Acres under the Ordinary System.*

	£	s.	d.
506 yards of 4-inch main socket pipe laid, at 4*s*.	£101	4	0
4 tees or crosses, with 3-inch arms, at 12*s*. 6*d*.	2	10	0
4 4-inch cocks, at 24*s*.	4	16	0
2412 yards of 3-inch socket branch pipe, at 3*s*. 4*d*.	402	0	0
20 hydrants for 2½-inch hose, at 34*s*.	34	0	0
20 tees to join hydrants to pipes, at 20*s*.	20	0	0
100 yards of India-rubber 2½-inch hose, at 10*s*.	50	0	0
Copper branch with brass cock and spreader complete	2	0	0
Hose, reel, and carriage	5	10	0
Total, for all things in the field	£622	0	0

4. *Estimate for* 102 *Acres with Mr. Love's Portable Surface Pipes for One-half the Land.*

	£	s.	d.
506 yards of 4-inch socket pipe for main, laid down, at 4*s*.	101	4	0
4 tees with flange, and for 3-inch pipe, at 15*s*.	3	0	0
4 cocks for 4-inch main, at 24*s*.	4	16	0
1206 yards 3-inch flange, with bolts and rings complete, at 4*s*. 6*d*.	241	4	0
12 hydrants for 2½-inch hose, at 34*s*.	20	8	0
12 tees for joining on hydrants to pipe, at 20*s*.	12	0	0
100 yards India-rubber hose, 2½-inch, at 18*s*.	50	0	0
Hose, reel, and carriage, with branch spreader	7	10	0
Total, for all things in the field	£440	2	0
Amount saved by my plan of portable pipes only	£181	18	0

5. *The same, under a method showing the Improved System of Irrigation by Hydraulic Engine, Pipes, and my Distributing Machine.*

	£	s.	d.
330 yards of 4-inch socket pipe for main laid down, at 4*s*.	66	0	0
2 tees with flange arms for 3-inch pipes, at 15*s*.	1	10	0
2 cocks for 4-inch main pipe, at 24*s*.	2	8	0
670 yards of 3-inch flange pipe for portable branches, at 4*s*. 6*d*.	150	15	0
10 hydrants for 2½-inch hose, at 34*s*.	17	0	0
10 tees to join hydrants to branch pipes, at 20*s*.	10	0	0
200 yards of India-rubber hose complete, at 10*s*.	100	0	0
Distributing machine	40	0	0
	£387	13	0
Amount saved by my system as compared with the ordinary plan	£234	7	0
Home appliances—*viz*. half of six-horse steam engine	80	0	0
Hydraulic engine and tank pumps	60	0	0
4 tanks for 50 acres Italian ryegrass, 8800 gallons each, at 19*l*.	76	0	0
1 mixing tank to hold 17,600 gallons	30	0	0
	£246	0	0
Total amount of capital invested on 102 acres under ordinary system	£868	0	0
Total amount of capital invested on 102 acres under my plan of portable pipes	£686	2	0
Total amount of capital invested on 102 acres by my improved system	£633	13	0

Northampton, 1859.

III.—*On the Commercial and Agricultural Value of certain Phosphatic Rocks of the Anguilla Isles in the Leeward Islands.* By Sir Roderick Impey Murchison, V.P.R.S., Director-General of the Geological Survey, and Honorary Member of the Royal Agricultural Society.

Having long been an Honorary Member of the Royal Agricultural Society of Great Britain, I have often regretted that I have never had it in my power to communicate anything of importance to the British farmer.

I am now, however, enabled to make an announcement which will, I have no doubt, be as acceptable to the readers of the 'Agricultural Journal' as it is interesting to the geographer and geologist, whilst it is likely to become very valuable to the merchant and shipowner.

A few weeks ago my eminent friend Sir William Hooker enclosed to me a letter from His Excellency Mr. Hercules Robinson, recently Governor of St. Kitts, in the Leeward Islands, and now appointed Governor of Hong Kong, accompanying a box of specimens of rocks taken from three localities in the Anguilla Isles, lying immediately to the north of St. Kitts, and requesting me to have the specimens analysed in the laboratory of the School of Mines under my direction.

It appears that the Americans, in the course of the year 1858, quarried away some 30,000 tons of rock, the greater part of an islet called Sombrero, to the north of the Anguillas, and sold the substance in the New York market at prices from 3*l.* 10*s.* to 6*l.* 10*s.* per ton, to the amount of 100,000*l.*, for the purpose, it is said, of regenerating the exhausted lands of Virginia. Subsequently the inhabitants of the Anguillas, knowing that some of their northern "keys" or rocky islets were similar in aspect to Sombrero, naturally desired to have these substances analyzed.

The analyses have been made by Mr. Charles Tookey in the laboratory of this establishment, under the direction of Dr. Percy, and are as follows:—

Little Anguilla.—The specimens from this islet do not contain a notable amount of phosphoric acid.

Little Scrub.—This sample contains 1·62 per cent. of phosphoric acid or 3·53 per cent. of phosphate of lime; but certain porous portions selected from the mass gave 25·75 per cent. of phosphoric acid or 56·21 of phosphate of lime. The porous portion of the *Little Scrub* rock contains also nitrogenous organic matter and a trace of potash.

Blowing Rock.—This sample contains 0·31 per cent. only of phosphoric acid or 0·68 per cent. of phosphate of lime.

The specimens sent home from the Sombrero Rock contain respectively—solid rock, 36·71 per cent. of phosphoric acid or 80·14 of phosphate of lime. The porous portion of the rock yielded 32·37 per cent. of phosphoric acid or 70·67 of phosphate of lime.

Now, although these specimens are much richer than those transmitted from the Anguillas, it is to be recollected that the former were taken from the heart of the rock; the Americans having cleared away all the overlying portions, even to the water's edge. On the other hand, the British specimens were merely gathered from the surface; and it is therefore probable that, when deeply quarried into, some of our "keys" may prove as valuable as the Sombrero rock.

We have yet to learn to what extent other rocks of the Anguilla Isles may be of as good a quality as those of the "Little Scrub;" but even if it be found that Anguilla, the chief island of the group, which is 20 miles long by 6 miles broad, does not contain any considerable quantity of this peculiar breccia, still the islets lying between it and the rock of Sombrero may be of considerable value. For, if substances similar to the breccia of the "Little Scrub"—which has all the external character of a bone breccia—shall be found to occupy several of these islets, the discovery must be considered one of great national importance, in providing our agriculturists, from a British possession, with a plentiful supply of a good substitute for the guano of Peru.

I trust, then, that Her Majesty's Government may deem it expedient to send out a competent geologist, or may direct one of the two geologists now surveying in the West Indies, to explore the "keys" and rocks at Anguilla, and define the extent over which these phosphatic substances may be distributed.

Museum of Practical Geology and Government School of Mines,
Jermyn Street, May 30, 1859.

IV.—*The Agriculture of the Islands of Jersey, Guernsey, Alderney, and Sark.* By C. P. Le Cornu, Beaumont, Jersey.

Prize Essay.

Jersey.—The Channel Islands in former times were very little known beyond the fact of their existence, but they may be said to have awakened as it were from a state of lethargy, and become a highly important although a small section of the British empire. Within the limits of these pages it being necessary to confine

ourselves strictly to what appertains to agriculture, we shall now take each island separately into consideration; for however close may be their relative position with regard to each other, on many essential points there is a difference which claims special notice.

Jersey, the largest and most easterly of the group, lies in latitude 49° N., longitude 2° 22′ W., being at a distance of 18 to 20 miles from the nearest coast of France. In form it is that of an irregular parallelogram, 11 miles long and 5½ miles wide. The surface of the island is intersected by a continuation of valleys, which in general run from north to south, gradually increasing in depth and width as they approach the south, until they in many places unite and form small but fertile plains. On the northern side the coast rises abruptly above the level of the sea, to a height ranging from 250 to 400 feet, whereas on its southern side it is in most places on a level with the water's edge; it follows from this inclination southwards that nature has done much to favour vegetation, for not only do the sun's rays fall more directly on the surface, but also the numerous streams, with which the valleys abound, run over a longer distance, and consequently increase from the number of tributary springs which flow into them; a circumstance particularly advantageous to so small an island, were it only for the greater number of water-mills which it enables it to have; but moreover this declivity gives great protection from the colder winds. With regard to climate, it is mild and temperate, the heat never excessive, nor yet the cold intense: the winters are such that it is not a rare occurrence for one to pass by without a flake of snow falling, or even the thermometer to remain above freezing point: during the winter months rain is most prevalent.

The island is computed to cover an area of 28,717 English acres, and is divided into twelve parishes, viz.:—St. Helier's, in which is the principal town and harbour, St. Saviour's, St. Clement's, Grouville, St. Martin's, Trinity, St. John's, St. Mary's, St. Ouen's, St. Peter's, St. Brelade's, and St. Lawrence's; the first six forming the eastern district, and the remaining six comprised in the western district.

The entire population amounted at the last census, in 1851, to 57,155; of this number one half are inhabitants of St. Helier's, the other half may be said to be evenly spread over the other parts of the island. St. Helier's holds a central and very advantageous position for the sale of produce, whether it be for exportation or for home supply. There are also two smaller towns having each its harbour, St. Aubin and Gorey; the former is in St. Brelade's parish, and the latter in St. Martin's, but very little business is done at either comparatively with St. Helier's.

When we consider the large population living on so small a surface—that there are two inhabitants to every acre—we almost wonder whence they derive their resources; but we must bear in mind that, although situated on a rocky bed, the soil of Jersey is particularly rich and highly productive. The rock is of the primary formation, void of any organic remains, chiefly granite, syenite, gneiss, porphyry, and schist, with other varieties belonging to this series. It might be supposed that the fact of the soil reposing on so rocky a bottom might produce meagreness, but it is not the case. The soil is a rich loam, varying in lightness in accordance with the stratum beneath it; if granite or syenite, it is lighter than where the other varieties of rock are found. The cause to which this difference is attributable is that immediately between the granite and cultivated soil is a layer of coarse gravel, which acts as constant drainage, whereas where the granite and syenite disappear no gravel is found, but a light clay forms the layer between the soil and rock. As a general rule the eastern district of the island may be said to belong to the latter formation, and the western to be more closely allied to the former, but in both cases there are exceptions. For certain kinds of produce the one is more esteemed than the other, but the universal opinion throughout the island is, that the eastern district is the richest and most productive. To bear this out it will only be necessary to state that the rent of land is considerably higher in this than in the other; and by comparing the two closely it will be found that the clayey bottom is the most advantageous; being retentive of moisture, it protects plants against drought; it also retains the properties of manure, which in thinner and more open soils are washed down by rain and lost: from this last remark it is not to be inferred that the soil of the island in any one part is altogether deficient of certain retaining properties; what is wished to be impressed is, that the varieties of soil are numerous, and differ, as has been said, in accordance with the strata immediately beneath. Here it will also be well to observe that certain localities in the vicinity of bays have through the violence of the wind from olden times become extremely light and sandy, but they nevertheless are tilled and have in many places become highly fertile, especially in the parish of St. Clement, which may be termed the garden of Jersey, from its great and early productiveness. Jersey is well studded with trees, much more so than either of the other islands; the oak, elm, chesnut, and ash are seen growing luxuriantly, but particularly the apple-tree may be noticed: formerly a large portion of land was devoted to the culture of this fruit-tree, but of late many have been destroyed, and replaced by the ordinary crops of grain, grass, roots, &c.

Land is held in various ways, either as farms on lease paying annual rent, or as freeholds for ever. In the former case the lease cannot extend beyond nine consecutive years; the conditions of leases are simple, generally commencing on Christmas-day: the tenant binds himself to pay to his landlord at a stated time the yearly rent, to till and manure the land well, observing the customary rotation of crops: on the other hand, the proprietor is bound to keep the house, farm-buildings, fences, and so on, in tenantable and good condition. A freehold is acquired by various means, either by paying down the full amount agreed upon, or by what is commonly done, paying a part only, and converting the remainder into what are termed quarters of rent, it being a sort of mortgage due on the property: formerly these rents were paid in corn, but they are now commuted for specific sums into money; each quarter being estimated at 15*s.* 5*d.* English money per annum. In all cases of purchase the purchaser is bound to pay down at least one-fourth of the gross amount, either in money or in quarters of rent. In such a case, when only part of the price of purchase has actually been paid down, and the remainder is due in annual rents, the purchaser is, to all intents, as much the proprietor as if he had paid down the full amount, and so long as he continues to pay the said rents regularly he is never disturbed, but he as well as his successors remain in perpetual possession of the property as freehold. The rents are guaranteed to the seller by the property sold, as well as by all other real property free from encumbrance held by the purchaser at the moment of purchase. Rents being always a property much in demand, and transferable, it follows that they can at any time be converted into cash readily. By this means the original owner reaps the income of his property, secured by the property itself, and which he can at all times re-obtain in case of non-payment; while on the other hand the purchaser, by regularly paying the rents charged, becomes the lawful and perpetual owner, and, moreover, he can at any time when his means increase get rid of his debt by purchasing rents of a similar nature, and assigning them to the original proprietor, though still continuing to be the lawful guarantee for the rents so assigned. This mode of tenure, complicated as it may seem, has proved good, for many persons without much means, but merely through industry and economy, have sprung up and become more wealthy than former proprietors, who, after disposing of their estates, lived on the income derived therefrom.

The great subdivision of property has caused farms to be of very small extent. The law of the island does not permit land or rents inherited to be devised by will, but they must follow the

law of succession: on the demise of a proprietor, the eldest son takes as his birthright the house, &c., with rather more than two acres of land adjoining, also one-tenth of the entire landed property and rents; the remainder is then shared, two-thirds among sons, and one-third among daughters, but in no case can a daughter take a larger share than a son. Thus large estates become very much divided, but in most cases the eldest branch purchases some of the portions allotted to the junior members, who have commonly turned their minds to professional or mercantile occupations. Very many houses will be found to which only 2 or 3 acres are attached, whilst others have 20 or 30, but an estate which contains 15 acres is by no means considered a small one, and rarely do any exceed 50 or 60 acres; there may, perhaps, be 6 or 8 such in the whole island. However limited may appear the size of these farms, still their value is considerable. The following are the prices at which land has been letting of late years, viz.:—In the immediate vicinity of St. Helier's 9*l.* per acre; at a distance of 2 or 3 miles 6*l.* 10*s.* to 7*l.* 10*s.*; beyond that 4*l.* 10*s.* to 6*l.*

Bearing these prices in mind, it will be observed that farming must be carried on with great care and attention, and that the farmer must be ever watching how to turn his occupation to the greatest advantage, otherwise his business would prove a failure. In Jersey almost every family residing in the country cultivate some portion of land adjoining their house; if but a garden they grow fruit and vegetables for the markets, and if they have 1½ to 2 acres of land they keep a cow, two or three pigs, and some poultry, increasing their stock in proportion to the extent of their occupation.

The Jersey farmhouse is a comfortable granite-built dwelling, sufficiently large for any ordinary family: the outbuildings are also substantial and conveniently constructed, comprising a bakehouse, stable, cow-house, pigsties, cart-shed, barn, granary, cider-press-house, store-rooms, liquid-manure tank, and various other conveniences, the whole on a scale suitable to the extent of land attached.

The cultivation of the soil is carried on in various modes; but there is one general and almost universal system followed; the only difference being caused by position or some striking change of soil. The rotation followed is this:—

1st year .. Turnips including all varieties, mangolds, parsnips.
2nd ,, .. Potatoes, also frequently carrots or parsnips.
3rd ,, .. Wheat, in which are sown clover and rye-grass.
4th ,, .. Hay.
5th ,, .. Hay.

After turnips wheat is sometimes sown, but in this case

clover is not added; the following year the land is again broken up for either potatoes, parsnips, or carrots, or perhaps oats may be sown with clover for the next year's hay-crop; but this latter change rarely occurs.

To illustrate more clearly the courses followed, and the proportions of ground allotted to each crop, we shall, for an example, take an ordinary farm of 20 acres, and distribute the land as is customary. A farm of this extent will generally comprise six or eight fields, including, perhaps, one or two orchards. The average size of fields throughout the island is from 2 to 3 acres; they are divided by fences thrown up with soil, which take up an extraordinary space; on the top, which is generally from four to five feet above the level of the fields and three to four feet wide, is grown furze, or wood for fuel. The land of late years having become of great value, the banks have in many places been removed and replaced by quickset or other fences of a similar nature. This is a great improvement as regards farming, for these banks are nothing more than a nursery for weeds and vermin; in some parts of the island, in the neighbourhood of quarries, stone walls are commonly seen; but although stone is abundant, walls of this description are expensive, and therefore not general.

A farm of 20 acres, as before mentioned, will, with few exceptions (where meadow land or orchards predominate), be distributed as follows:—

	Acres.
Hay and pasture	10
Turnips	2
Mangolds	1
Parsnips	1
Carrots	$0\frac{3}{4}$
Potatoes	2
Wheat	$3\frac{1}{4}$
	20

The stock usually kept will consist of—

Horses	2
Cows	6
Heifers	6
Pigs	8

To manage the above, and keep the whole in proper order, will require the constant attention of 4 persons—2 men and 2 women. In most cases the farmer has not recourse to assistance beyond that of his own immediate household; it is, indeed, a rare occurrence for a tenant-farmer to hold a farm of this extent unless he can rely upon his own family for assistance. The usual price paid for labour is 2*s.* per day for a man, and 1*s.* for a

woman—if not fed in the house; but if they receive their meals, the pay is 1*s.* per man, and 6*d.* per woman. There is also another class of servants who board and lodge altogether on the premises; in this case, the maid servants are paid from 8*l.* to 10*l.* a year, and the men from 12*l.* to 14*l.* The former are in most cases natives, but many French and Irish are also found; the men are generally English or French: in the eastern district of the island the latter prevail, and in the western district English are mostly found.

Before entering into the modes of cultivation it will be well to understand the arrangement of the farmhouse, outbuildings, yards, &c. The most usual plan is for the dwelling-house to border upon the road-side, with only a small garden or yard intervening. If it be a garden, it is laid out with flowers and vegetables; if a yard, it is kept gravelled and clean, and through it is a path which leads to the principal entrance. On this side of the house (which usually faces the south) is frequently trained a vine, which adds considerably to its appearance. The interior contains, on the ground-floor, two kitchens, one parlour, and a room appropriated for the dairy: on the upper floor are four bed-rooms.

The farm-offices are built near the dwelling-house, in some cases actually adjoining to it; they are convenient and compact, and calculated rather for these objects than for appearance. The bakehouse is a small room, containing a bread oven, and a copper for boiling or steaming roots; this room is also frequently used as a washhouse. The horse and cow stables are inelegant, but paved and divided into stalls. The pigsties are large and well constructed, entirely built and paved with granite; generally there are three or four of these sties attached to the outbuildings of a farm such as we are now describing. Near these is the manure-pit, which contains the whole of the manure made on the premises; and in the neighbourhood of the pit is the liquid-manure tank, sunk frequently in the form of a well and cemented. It is so constructed as to receive all the drainage from the different stables, &c., as well as what may overflow from the manure-pit in cases of heavy rain. This valuable liquid is emptied by means of a pump, and applied to the grass-land in the spring. The barn is built in the ordinary way: in most cases it is floored with wood, which is considered by far the best flooring for threshing upon with flails, as is customary in the island. The granary is a small room above or near the barn, divided into partitions for the reception of corn when threshed and cleaned. Near the barn is always the stackyard.

The cider-press house is also another appendage of the farm offices. It is usually a large room, wherein is fixed a circular

granite trough, into which runs a stone wheel; this wheel is connected by an axle to a pillar, which stands upright from the ceiling to the centre of the ring, and turns round as it is moved. The apples are thrown into the trough, and thus crushed into pulp. In some farms mills are used, as in England. The press for squeezing the pulp consists of a frame, about six feet square and nine inches deep, that rests upon a beam, through each end of which runs a large wooden screw. The screws are fixed perpendicularly, and are connected with a beam above the frame similar to that beneath it. The pulp is put up in layers, each being divided either by a horsehair cloth or a thin coating of corn-reed, and when done, by turning the screws the upper beam is lowered upon the pulp, by which means the cider is drawn; pressure is applied until nothing remains but the dry cheese. Other presses of more modern date have only one screw —a fixture—which acts upon the centre of the upper beam; these screws are generally of iron, and are more effective than the others. If much cider be made, immediately above the press-house is a chamber, into which the apples are stored till they become ready for use. There are no means of ascertaining the actual quantity of cider made on the island; but it must be large, as it is the principal beverage of the middle and lower classes. Some farmers are not sufficiently particular in assorting their fruit, but allow a mixture of different kinds, so that ripe and unripe meet in the mill or trough—the result is, of course, an inferior article; there are others who pay proper attention to cider-making, and produce it excellent.

The apples commonly grown for making cider are known in Jersey as Noir Binet, Petit Jean, Limon, Bretagne, de France, Romeril, Frais Chien, Amer, Pepin Jacob, Carré, with many other varieties. The entry of foreign cider into the island is forbidden by law.

In closing the description of the farm-offices we will mention the cart-sheds, which are used for general purposes, and sufficiently spacious and lofty to shelter the largest loads. There are also other rooms, such as store-rooms, but there is nothing peculiar in them.

We shall now turn our attention to the cultivation and cropping, and shall commence our operations with January, following the year through its different seasons. The commencement of a new year signals the preparation of wheat-land and sowing. True it is that some sow their wheat a week or ten days before Christmas, but the general month is January; it should never be sown later than the 14th. There is an old superstitious custom observed by many with regard to the exact time of sowing wheat: it is when the moon is in its third or

its fourth quarter. In former times this was much more thought of than it is now; only those of the old school attend to it. As before observed, wheat is sown in most cases after potatoes, parsnips, or carrots; in this case the land is clean, and requires no preparation beyond manuring. The manure employed is generally vraic ashes, *i. e.* the ashes produced by the burning of dried seaweed. Seaweed is collected in great abundance on the coast and dried for the purpose of burning. If the land be rich, as in most cases it is, having been highly manured for the root-crops, $2\frac{1}{2}$ tons per acre of ashes will be deemed sufficient. A few days before ploughing these ashes are carted from a dry place (in which they are stored and kept as free as possible from the action of the atmosphere) to the field, where they are spread evenly on the surface. If the sowing takes place before Christmas, it is frequently the custom to sow the seed on the surface before ploughing, and then plough it in with the manure about 5 inches deep; this mode is preferred by many. If sown in January—the usual time—the land will first be ploughed about 7 inches deep, then the seed be distributed broadcast, and, if properly done when the ground has been well harrowed lengthways, the seed will rise in drills the breadth of the furrows. Nothing more is done to it before the end of March, when it is hand-weeded, if required, prior to the clover and other grass-seeds being sown in it, which takes place as soon as the wheat is 4 or 5 inches high; it is then altogether left until the harvest season, which we shall describe later. The varieties of wheat commonly sown are known in Jersey as Velouzé and Petit Blanc; the former is the best for rich soils on account of the strength of its straw, which prevents it from being laid by storms or continued rain, but the Petit Blanc is more esteemed for the quality of its flour. The Velouzé, or Downy, is the most prolific, yielding, in the rich and well-cultivated parts of the island, 50 bushels per acre, but, as a general medium, 45 bushels may be taken. The quantity of seed sown varies; formerly, as much as 200 lbs. weight was sown per acre, but now one-fourth less is used, and found to be sufficient. The only preparation that the seed undergoes before sowing is to steep it in bluestone and water for 8 or 10 hours. Sometimes salt is used, in which case it is mixed with hot water until it is strong enough to float a potato; when cold the wheat is thrown into it, and left for 10 or 12 hours, after which it is taken out, and dried with a little unslacked lime.

The wheat being sown, the next object will be to attend to the parsnip and potato crops, which in due rotation follow turnips. For parsnips, the land is covered with a good coating of seaweed, which is gathered fresh and applied at once;

that done, the whole is ploughed in 2 or 3 inches deep, and allowed to remain so until the end of February, and sometimes later. By this means the roots of the different plants which may have sprung up since the turnips had been removed are exposed to the air and killed, and their leaves rotted with the seaweed beneath. Here it may be observed that seaweed decomposes quickly, and leaves the soil in a pulverised and open state; it is well harrowed, and stable manure carted and spread at the rate of 20 to 30 tons per acre; then the ploughing takes place, in a manner which will seem singular to those unacquainted with the Channel Islands. Before describing this, it will be well to mention that, when oats are sown, it takes place in the early part of February. Only inferior land is tilled for this grain; it is ploughed in the same manner as for wheat, but no manure is applied. The quantity of oats grown in the island is so trifling as to be unworthy of notice.

Returning to the mode of ploughing for parsnips, a trench is made from one end of the piece to the other, from 2 to 3 feet wide and 15 inches deep; then a common plough, drawn by two horses, turns the manure, with a sod 4 inches thick, into the trench. Following this plough, and immediately in its path, is another plough, of huge dimensions, drawn by six or eight horses, which works at such a depth as to throw up a thickness of one foot at least of subsoil over the crust and manure which the smaller plough has turned over; and thus they go round until the piece is finished, after which it is harrowed, and the seed sown broadcast at the rate of 3 to 4 lbs. per acre; it is then slightly harrowed in, and left until the weeding season arrives. When the young plants have attained one inch or so in height they are hand-weeded; this was formerly repeated three times, but has given way to hoeing, which, when carefully done, answers the purpose quite as well, if not better. When first thinned, the young plants are left from 5 to 7 inches apart, and the second time about 1 foot. In some cases they are hoed three times, much depending on the state of the soil; they are then left until the fall of the year, nothing more being done to them.

The potato land is prepared in the same way as for parsnips, the only difference being that no seaweed is employed as manure; is is supposed to give to the tuber a disagreeable taste. When the ground has been ploughed and harrowed, the plants being cut, the setting takes place. A small one-horse plough is used for the purpose of making drills, which generally are eighteen inches apart and five inches deep; following the plough, young people are employed to lay the sets,—these are placed at a distance of nine or ten inches from each other: on its second turn

the plough opens a fresh drill, and with the mould raised covers the sets in the one just planted. The quantity of seed used is about 20 cwt. per acre. When the young plants are about to penetrate the surface, the ground is harrowed lightly to loosen it, as well as to destroy any small weeds which may have sprung up since the planting. The harrow is very beneficial, so long as the young plant is not disturbed; but in order to avoid this, of late many farmers have used the fork. When five or six inches high, the plants are earthed up with a small plough having a double mould-board; in most cases horses are not employed for this work, but the plough is managed by two men, one drawing and the other directing it. Here ends the work before digging them out of the ground. The sorts commonly planted are—Early Shaws, Forty-folds, Gold-finders, Crapaudines, and Kidneys, for early produce; and the Regent, Scotch, Pink-eye, and Jersey blue, for later crops. The Early Shaws and Forty-folds come ripe the first; the Gold-finder is also a fine potato, but not quite so early: different varieties of Kidneys are planted, but only in gardens, never in any quantity,—they are not so much esteemed by farmers as the other sorts. The Regent is the best potato grown, be it for quality or quantity of produce; formerly the Scotch was the most esteemed, but of late years the return has been very small and poor. The Pink-eye is a worthless sort, which should never have been introduced into the island; it is very productive, but of a bad quality. The old Jersey blue, once universally grown, is now almost lost, very few seem to cultivate it. Jersey was once famous for the cultivation of potatoes. Before the visitation of Providence upon the plant, the enormous produce of 18 tons per acre was not uncommon, but now it is a good crop which yields from 8 to 9 tons on the same quantity of land. Some farmers prefer spade-digging to the large plough for potatoes. A trench is opened at one end of the field, then with the spade the crust is taken off and thrown into it in seams about 18 inches wide and 4 inches thick; over this is spread the manure evenly, then the subsoil is dug and put on the surface; so that when the sets are planted they are almost on the manure itself. This is considered the best mode to ensure a good return, for, in the case of ploughing with the large plough, the manure is frequently sunk too deep, and its properties lost. For parsnips it is very different; this root penetrates extremely low and arrives at the manure, but the potato unless planted very deep does not obtain the benefit. During the months of January, February, and March, the farmer attends to his pastures. The westerly winds prevalent during the winter months bring with them quantities of seaweed; this is an excellent dressing, producing grass of the best quality; cattle will feed with avidity on pastures

dressed with it: another top-dressing applied to grass is the liquid manure from the tank. Some years ago no attention was paid to this important manure, but of late, since the Agricultural Society has made known its richness, it is universally saved and applied to grass-land.

In April mangold-wurtzel is sown. The land is prepared and manured in the same way as for potatoes; sometimes sea-weed is added. The seed is distributed in drills—from 24 to 30 inches apart and 3 inches deep, and generally thick enough to admit of more than one-half of the young plants being removed or destroyed when hoed. The first hoeing takes place as soon as the rows are visible, the second when the plants are sufficiently strong to admit of thinning; and if in some places the seed has failed, some are transplanted to fill the vacancies; for the third time they are cleaned of weeds, when the plants have attained the size of carrots. The under leaves of mangolds are frequently given to pigs during the summer; some persons object to these being removed, on the ground that it injures the plant, but the detriment sustained, if any, is more than compensated by the benefit which swine derive therefrom. The produce of mangold averages from 40 to 50 tons per acre. To give an example of its enormous produce I shall quote a paragraph which I had occasion to notice in the last year's Report of the Royal Jersey Agricultural Society.

"It is observable that the produce of the turnip crop has been gradually diminishing during the last five or six years, whilst that of mangolds has been increasing; whether this has arisen from improper culture, or unfavourable seasons, does not appear clear; that the latter root is more to be depended upon is evident from the fact of its increased produce in dry as well as in wet seasons; last year, for instance, has been dry, and notwithstanding the weight per vergée has not diminished. In St. Peter's, Captain Balleine produced the enormous quantity of 32 tons to the vergée, free from tops, being upwards of 70 tons per acre, in a field directly adjoining the marsh in that parish; and he asserts that, if the adjoining piece of land in the marsh had been similarly cultivated, it would have produced a similar result. This produce, estimated at 15*s.* per ton, is upwards of 50*l.* per acre, or 24*l.* per vergée. This he obtained by breaking up an old pasture, carting to it 15 loads of old bank soil per vergée, and manuring with fresh stable dung."

The long red and the yellow globe mangolds are both cultivated; in some instances the globes have been known to produce a heavier crop than the long red, but that is unusual; the latter are in almost all cases the most productive in weight.

Carrots do not occupy so large a space in the root crops as parsnips or mangolds, but they are deservedly prized by many. In the outline given at page 36 of the rotations followed, carrots are placed to succeed turnips; sometimes also they follow wheat, *i.e.* when the wheat has been sown after turnips, and no clover-seed added. In both cases the sowing takes place at the end of April; the seed is

generally sown broadcast, and the young plants treated in the same manner as parsnips. Carrots thrive best in light or well-pulverised land; the soil is ploughed deep, and manured as for potatoes. The varieties chiefly cultivated are the Altringham and Belgian. The root is much esteemed as food for horses during the winter months. The produce, when a good crop, is about 30 tons per acre, and instances of 36 tons per acre are not uncommon.

When barley is sown, the common time is April: this grain as well as oats is only cultivated on poor soils, which are not calculated for wheat; but the mode of ploughing and sowing is the same. It is put in after turnips; if after potatoes, clover-seed is added for the next year's hay crop.

When May begins, the farmer thinks of preparing his land for swedes. The pasture intended to be broken up will have been fed off closely; he will then scarify it, and at the end of the month pare it with his plough as thinly as possible, after which it is harrowed well with a heavy two-horse harrow; stable manure is then carted and spread on the surface at the rate of 25 tons per acre. Sometimes seaweed is also used and found good; in short, it may be said to be applied for all roots, especially in the immediate neighbourhood of the coast, where it most abounds. When the land has been made ready, it is ploughed with four horses, six or seven inches deep, or so that what may have been on the surface is entirely buried. If the seed be drilled the ground is harrowed, and then distributed in drills 14 inches apart. When the young plants have three leaves they are lightly thinned, and subsequently they are again hoed and left at a distance of 14 inches from each other. Of late years the Swedish turnip has not answered well in the island; the young plants have been devoured by insects as soon as they made their appearance above ground, and consequently had to be sown a second time. It is the opinion of many that they should not be put in too early, nor yet immediately after the land is ploughed, but that a certain time should be allowed for all grubs, &c., to disappear. Two varieties of swedes are grown in Jersey, the purple and the green. A fair crop produces about 26 tons per acre.

About the middle of June the hay season commences by cutting the two years old clover, which is always ripe before the main or one year old crop. It is allowed to stand too long before cutting, for the rye-grass which is in it dries up, and its stems become wiry and lose their nutriment; moreover the clover-leaves rot near the foot, and the hay gets coarse and hard. The farmer, regardless of quality, thinks that by this means he obtains a heavier crop; he forgets that by cutting early he will

have a better second crop, as well as a better chance of saving it without rain. When the grass is mown it is spread with forks, and so left for one or two whole days; if the weather be fine it is again turned over, and afterwards made into small cocks to ferment; these are again put two into one, and the following day carted to the loft or rick. For hay to be properly seasoned it should not be put in before it has well fermented in cocks, otherwise it will get mouldy. A prevalent custom with many is to put the hay in lofts above the stables; it may be convenient, but it does not keep nearly so well as in ricks. When made, ricks are allowed to remain uncovered for some time for evaporation, then they are covered with thatch. On small farms the hay is sometimes made up into bundles weighing 10 or 12 lbs. each, and then stored. A good crop of one year old clover will yield upwards of 4 tons of new hay per acre, but the two years old will seldom reach more than $3\frac{1}{4}$ tons.

Early potatoes are dug and sent to Covent Garden market in June; the earliest forwarded are generally during the first fortnight of May; the produce averages about $7\frac{1}{2}$ tons to the acre. It must not be imagined that these are grown throughout the island, it is only in parts most favoured by nature. The potatoes are dug out with a plough, one row being taken at each furrow. When the furrow has been turned it is forked over, and the tubers collected. A crop of turnips is frequently obtained after early potatoes.

In the summer the fences are trimmed, *i.e.* the grass growing on the sides is cut and given to cattle in the stable. The early root-crops are also attended to.

Turnips for early use are sown in July. The land is prepared in the same manner as for swedes; but little manure is applied. The red and the green tankard, the purple and the green topped Aberdeen, and the white globe are all grown; but the turnip does not thrive so well as formerly, although much more attention is paid to its culture; some years ago the roots attained one-third more size than at present, now the plants are blighted as soon as they attain a certain size. The produce of the Aberdeen is small, that of the white globe is heavier, and, as an early turnip, is the best variety known in the island. Cattle are fed on the small turnips first, and when swedes are not grown the largest and best of the other sorts are put aside for later use.

In an official capacity I had occasion last year to visit many of the best farms, and in one instance only did I see turnips free from blight; these had been sown much later than usual, and manured with seaweed, known in the island as vraic-de-mai; this seaweed is different from all other varieties,—it is of the colour of yellow ochre, and is washed on the beach at one particular

season only, which appears to be its flowering season, for masses resembling flowers come in with it; no other variety is more prized for its ashes than this.

Towards the end of August the harvest becomes general. Oats and barley are first cut, then wheat. Grain of all descriptions is cut with the sickle, and is harvested very ripe; it is not considered ready to reap before the ear curls downwards; it is then cut within three or four inches of the ground, and packed up neatly in small sheaves. In the field the sheaves are made into small stacks, and left until carted into the stackyard. The mode of stacking on staddles is the same as in England. When the stacks are made, they are covered with small packs of reed; each pack is tied at one end, and spread out like a fan at the other; these are laid above each other like slates: if the stacks be in an exposed situation the covering is made fast by twisted bands of straw thrown and fastened across the top.

Wheat is threshed out across a bench made for the purpose. When a man has threshed out 400 sheaves in a day he is considered to have worked well. Sheaves when threshed out are called sonbats; these, if reed is required for thatching, are combed out and packed up ready for service; but if used for fodder or litter, they are threshed with flails and made up into bundles. For cleaning wheat a winnowing-machine is used. These are made in the island, and work perfectly well.

After the removal of the wheat, the young clover sown in it springs up at once, and becomes in a short time excellent pasture; it is fed down closely before winter, else it would be apt to perish: great benefit would result from rolling the ground heavily, for it has been observed that where the ground is hard in winter, the hay-crop will be good in the following summer.

In September and October the tops of parsnips are cut and given to cattle; they are found to impart great richness to milk, and cattle are very fond of them. The second crop of hay (*i.e.* clover) is generally cut and made in October. The late potatoes are also dug. The work is done as before explained; when the piece is finished, it is harrowed and left. In taking up potatoes the small ones are put aside for pigs, and the saleable ones stored in a close room appropriated for that purpose. The principal markets for this produce are the mining districts of Wales, the Bristol Channel, Gibraltar, Malta, and other ports in the Mediterranean; to these different places potatoes are sent throughout the winter, but of late years they form but a small item in the list of exports compared with former times.

In November and December mangolds (the tops having been cut and given to cattle) are taken up and stored in sheds. The same with carrots, parsnips, and Swedish turnips. Tankards,

Aberdeens, globes, &c., are taken up as required for immediate use. This is also the time for planting the large cow-kale. A piece of ground is selected in a sheltered spot, generally in an orchard close to the house; it is deeply dug and manured with seaweed, sometimes with stable-manure. The plants are put in at a distance of two feet from each other, and, when they have attained a certain height, the ground is hoed up against them, and then frequently more seaweed is added on the surface between the rows. Nothing more is done to them. As the leaves are required they are gathered (taking always the lower ones) and given to pigs. These plants grow up to an astonishing height, frequently as much as 7 or 8 feet. Here ends the farmer's work as regards his fields and crops; we shall now consider the different implements in his possession, commencing by the most ancient and important of them all—the Plough.

The Jersey plough is clumsy and unwieldy in appearance, but that it suits the soil and culture well is beyond doubt. The beam and handles are always made of wood, the latter considerably shorter than those of English implements. The mould-board and share are large, so that a furrow 14 inches wide can easily be turned. The plough rests upon a two-wheel fore-carriage, to which it is connected by the draught-chain, not altogether unlike the two-wheel Berkshire plough with gallows. The depth and width of furrow are easily regulated. The fore-carriage is very important, making the plough much more steady and manageable than it would be if the wheels were fixed to the beam, especially when the fields are small, and consequently the turns frequent.

The above plough is used for all general purposes; and, although various modifications have been tried, no very great improvement has been effected. Some time since, the Royal Agricultural Society of the island endeavoured to determine, by means of trials with various other ploughs, whether the old Jersey implement could maintain its superiority. This trial took place under certain disadvantages; still, from the manner in which the Jersey plough worked, as well as from the proportion of draught required for its propulsion, the Committee could not forbear from pronouncing it the best in the field: its work was even, and the whole surface entirely turned over and buried.

Several implements, such as winnowing machines, scarifiers, and harrows, are mostly made after English designs. Chaff-cutters, turnip-slicers, scythes, hay-rakes, &c., are imported from England. Drilling machines are not much in use as yet; some of Druce's, Hornsby's, and others, are occasionally to be met with.

The carts are simple, light, and convenient. They are used for harvesting by removing the head and tail boards, and fixing on ladders.

The large plough used for subsoiling is made somewhat after the pattern described, but of much larger dimensions; that used for potato-planting is the subsoil plough on a very small scale.

There not being any great peculiarity in any of the other implements, we shall now consider the farmer's stock.

In Jersey, horned cattle constitute the mainstay of agriculture; it is that upon which the farmer chiefly depends for money to pay his rents. Although the Jersey cow has been the subject of much notice in different publications, and is known to all who turn their attention to agriculture, still within these pages some remarks on the originality, value, and peculiarities of the breed are indispensable. The animal known in England and elsewhere under the name of Alderney cow is the same which is now under our consideration. The reason for the breed going under the name of Alderney is, that from that island the first were exported to England. At present but few are obtained from Alderney. In form the Jersey cow is deer-like, and small in size; the colours mostly prized are the light red and white, the brown, and the fawn; brindled specimens are rarely seen; they are not at all valued, and may be purchased extremely cheap. The cow is naturally quiet, so much so that a mere child can manage it. The form it should possess will be best understood by referring to the following points, which are those that guide the judges at the different exhibitions held under the auspices of the Royal Jersey Agricultural Society:—

"*Scale of Points for Bulls.*

Article.		Points.
1.	Pedigree on male side	1
2.	Pedigree on female side	1
3.	Head fine and tapering	1
4.	Forehead broad	1
5.	Cheek small	1
6.	Throat clean	1
7.	Muzzle fine and encircled with a light colour	1
8.	Nostrils high and open	1
9.	Horns smooth, crumpled, not too thick at the base, and tapering, tipped with black	1
10.	Ears small and thin	1
11.	Ears of a deep orange colour within	1
12.	Eye full and lively	1
13.	Neck arched, powerful, but not too coarse and heavy	1
14.	Chest broad and deep	1
15.	Barrel hooped, broad, and deep	1
16.	Well ribbed home, having but little space between the last rib and the hip	1

Article.		Points.
17.	Back straight from the withers to the top of the hip	1
18.	Back straight from the top of the hips to the setting on of the tail, and the tail at right angles with the back	1
19.	Tail fine	1
20.	Tail hanging down to the hocks	1
21.	Hide mellow and moveable, but not too loose ..	1
22.	Hide covered with fine and soft hair	1
23.	Hide of a good colour	1
24.	Fore legs short and straight	1
25.	Fore arm large and powerful, swelling and full above the knee, and fine below it	1
26.	Hind quarters, from the hock to the point of the rump, long and well filled up	1
27.	Hind legs short and straight (below the hocks), and bones rather fine	1
28.	Hind legs squarely placed, and not too close together when viewed from behind	1
29.	Hind legs not to cross in walking	1
30.	Hoofs small	1
31.	Growth	1
32.	General appearance	1
33.	Condition	1
	Perfection	33 points.

"*Scale of Points for Cows and Heifers.*

Article.		Points.
1.	Pedigree on male side	1
2.	Pedigree on female side	1
3.	Head small, fine, and tapering	1
4.	Cheek small	1
5.	Throat clean	1
6.	Muzzle fine and encircled with a light colour ..	1
7.	Nostrils high and open	1
8.	Horns smooth, crumpled, not too thick at the base, and tapering, tipped with black	1
9.	Ears small and thin	1
10.	Ears of a deep orange colour within	1
11.	Eye full and placid	1
12.	Neck straight, fine, and lightly placed on the shoulders	1
13.	Chest broad and deep	1
14.	Barrel hooped, broad, and deep	1
15.	Well ribbed home, having but little space between the last rib and the hip	1
16.	Back straight from the withers to the top of the hip	1
17.	Back straight from the top of the hips to the setting in of the tail, and the tail at right angles with the back	1
18.	Tail fine	1
19.	Tail hanging down to the hocks	1
20.	Hide thin and moveable, but not too loose	1
21.	Hide covered with fine and soft hair	1
22.	Hide of a good colour	1
23.	Fore legs short, straight, and fine	1

Article.		Points.
24.	Fore arm swelling, and full above the knee, and fine below it	1
25.	Hind quarters, from the hock to the point of the rump, long and well filled up	1
26.	Hind legs short and straight below the hocks, and bones rather fine	1
27.	Hind legs squarely placed, not too close together when viewed from behind	1
28.	Hind legs not to cross in walking	1
29.	Hoofs small	1
30.	Udder full in form, *i.e.* well in line with the belly	1
31.	Udder well up behind	1
32.	Teats large and squarely placed, being wide apart	1
33.	Milk veins very prominent	1
34.	Growth	1
35.	General appearance	1
36.	Condition	1
	Perfection	36 points.

"No prize shall be awarded to bulls having less than 25 points. Bulls having 23 points, without pedigree, shall be allowed to be branded, but cannot take a prize. No prize shall be awarded to cows having less than 29 points. No prize shall be awarded to heifers having less than 26 points. Cows having obtained 27 points, and heifers 24 points, without pedigree, shall be allowed to be branded, but cannot take a prize. Three points shall be deducted from the number required for perfection in heifers, as their udders and milk-veins cannot be fully developed; a heifer will therefore be considered perfect at 33 points. N.B. 'Pedigree' means the offspring of a prize or decorated male or female stock."

In order to derive the greatest possible advantage from his cows, the Jersey farmer endeavours to arrange for them to calve during the first three months of the year; that is, when vegetation speedily advances. In the winter cattle are always housed at night: when they come in (about four o'clock in the afternoon) they are milked, after which each receives about three-fourths of a bushel of roots and a little hay; they are then left until eight o'clock, when a bundle of straw is given to each one. The following morning they are attended to at six o'clock, or even before that hour; having been milked, they again receive the same allowance of roots and hay as before-mentioned, and at nine o'clock are turned out, if fine, in some sheltered field or orchard; then the stables are cleaned out, and the bedding renewed if required. Cows are dried one month or six weeks before calving; bran mashes are given to them about the time of parturition, and continued for a fortnight after the calf is born: at no other time do they receive this food. Bull calves intended for the butcher receive the cow's milk for about a month or six weeks, then they are considered fit for sale. A good calf will sell for about fifty shillings, some for more, but many for less. If the calf be a

heifer she is always reared, and kept in the island until she is two years old; when, if not required, she is sold for exportation. Returning to the cow: two weeks or so after calving, if the weather be very fine, she is turned out to grass in the day-time: it is the custom in all the Channel Islands to tether cattle; the tethers are made of small chain; a spike about one foot long is attached at one end and driven into the ground; the other end is tied to the cow's halter, the latter being made fast at the base of her horns; the length of these tethers is altogether about four yards. During the day cattle are frequently moved, generally every three hours, and sometimes oftener; drink is given to them in the morning on leaving the stable, and at noon; if it be summer-time, they receive it also in the evening. About the month of May they are allowed to remain out at night, and continue so until the end of October, when the system of housing above described recommences. During summer cows are frequently milked three times a-day; and when the weather becomes very warm they are brought into the stable for a few hours, else they would be tormented by the flies. At this period (height of summer) a great diminution takes place in their milk; but as the heat ceases towards the fall, it rapidly springs up again to what it was in the spring: this is the time when butter is crocked for winter supply. A cow is in her prime at six years of age, and continues good until ten years old; many are kept that are much older, but then they begin to fall off. In general, cows have their first calf when much too young; at two years old is the usual time, but then their produce is small, and continues so for at least a twelvemonth, when it gradually increases until it arrives at maturity. A good cow on the average gives fourteen quarts of milk per day, or eight or nine pounds of butter per week: instances are common of cows giving twelve or even fourteen pounds of butter in one week, but that is above the average figure.

Two years old in-calf heifers sell in ordinary years at the rate of 12*l.* per head, but there is a great fluctuation at times in their value; last year the price was higher than had ever been known.

A great improvement has taken place in the breed of cattle within the last twelve or fifteen years, which is attributable to the formation of agricultural societies in the island; by this means the farmer has received instruction, and has had pointed out to him the real merits of his stock. It is a well-known fact that before these societies existed cattle were sold for very little more than one-half of the sum that they now fetch. The value of a first-class cow, four years old, is at this moment 25*l.*, of a two-year-old heifer 14*l.* Bulls are seldom kept after their second

year, for they become extremely wild and troublesome: they may be purchased at this age for 10*l.* or 12*l.*; some of the best yearlings are frequently sold as high as 16 sovereigns: an ordinary one-year-old bull can be bought for 8 sovereigns. Very few oxen are fattened: the island is supplied with beef from France. A law exists in Jersey, by which the entry of all foreign bulls and cows is prohibited; this was passed by the States of the island a long time since, in order that the island breed should maintain its purity, which it has done hitherto, and no doubt will continue to do for a long time to come, if we judge from the tenacity with which every native adheres to it.

The horses used on farms do not form any distinct breed; some are imported from France, others from England, and some are bred in the island; the farmer generally selects for his purpose a small compact animal calculated for all work. In former times there did exist in Jersey a small breed of horse, which was extremely hardy; its colour was black, and until lately it was to be found pure, but now it has given way to animals of better symmetry. The horses are tethered in the same way as cows, and being accustomed to it by degrees get quite reconciled to their narrow limits. Their food in winter consists of hay, straw, oats, and carrots—it would be difficult to say what proportion of each; the animals that fortunately fall into good hands are well taken care of, but there are many that are comparatively ill provided for.

The pig commonly found in the Jersey farm is a large white animal, no doubt of French extraction, but greatly ameliorated by crossings which have taken place with English breeds. Sows generally litter in the spring and in the fall of the year—the first litter about March. Young pigs are sold when six weeks old at 10*s.* to 15*s.* each. When young, pigs are fed on sour milk and cabbage-leaves; to this is added bran or pollard: when they have attained a certain age small potatoes, cow-kale, and mangold-leaves are given them, with any other green food which may be grown. When the period of fattening commences parsnips are given them,—they eat these raw for some time with their milk, &c.; then, for six weeks or so before killing, the parsnips are steamed, and barley or oatmeal is added. A pig thus treated will, when killed at ten months old, weigh generally about eight or nine scores. The meat is cut up and salted, and becomes the staple food of the country people.

The breeding of sheep is not attended to; a few are kept in some of the principal farms, but they are considered more ornamental than profitable. The Jersey farmer pays the greatest attention to his cows, which bring him a better return than any other stock in his possession. The dairy itself is usually a small

room, having a northern aspect; it is paved with stone or brick, and shelves are fixed against the walls, whereon is placed the milk prior to skimming. The cows are milked into tin cans, linen strainers being first placed over the top to prevent anything falling into the milk. When the milk is brought into the dairy it is poured into coarse brown earthenware vessels, and left until the cream has set; the latter is then removed and the sour milk which remains is given to the pigs. Cream is seldom churned oftener than once a-week, except in the height of summer: the common box churn is generally used. The mean time for making butter is about thirty minutes, but it depends on the temperature. When the butter is made it is taken out and put into a large bowl, and worked with a wooden spoon until all the remains of milk have been removed; cold water is worked in at the same time to purify it: when finished, a small quantity of fine salt is added, it is then made up for sale into cakes of 1 lb. weight. If it be kept for winter use, one pound of salt is mixed with every sixteen pounds of butter; it is then put into earthenware jars, and salt and water poured on the top. No cheese is made in the island.

The cows and heifers exported during the last three years have been as follows:—

	1856.	1857.	1858.
Cows and heifers	2153	1188	1567

Jersey containing at this moment a population exceeding 60,000, it cannot be supposed that the island can produce sufficient for its consumption. France supplies it with oxen, calves, pigs, sheep, and poultry, as well as eggs, and frequently flour, wheat, barley, oats; but when the French ports are closed against the exportation of grain, flour comes from America, oats and barley from the Baltic. Jersey is chiefly supplied with cattle and grain from the foreigner: it is not to the injury of the Jersey producer, and much to the advantage of the consumer, for both are imported at a lower rate than that at which they could be produced, and the Jersey farmer is left to employ his time and capital in a way more profitable to himself and the island at large.

The population of Jersey may be classed under the following heads — natives, English, Scotch, Irish, and foreign. The natives may be computed at 47,000; English, Scotch, and Irish 13,000; French, &c., 2000. The management of the island affairs is entirely in the hands of the native inhabitants: although many from the mother country sojourn here, still they rarely take any part in what concerns the island itself; they

chiefly inhabit St. Helier, and principally consist of retired naval and military men living on their incomes; the French and other foreigners are for the most part artisans and servants.

The love of independence dwells in the heart of all Jerseymen, who may be said to be hard-working people, straining every nerve to better their position. The country-people in particular have a strong disposition for the acquirement of money. The origin of this is easily detected; independence in worldly circumstances is absolutely essential towards independence of character and action; men therefore employ the means to secure this independence; with acquisition, too, grows the love for more. Thus we may easily understand how, in a small community like Jersey, its members, gradually enriching themselves and perceiving the yearly results of frugality, should acquire habits which border upon parsimony.

Limited as may appear the agriculture of Jersey, it has nevertheless attracted, in several instances, the attention of strangers. In the fall of 1856 the Agricultural Society of the Department of "La Seine Inférieure," in France, deputed two learned members of that society to the island, in order to report particularly on the process followed in the manufacturing of cider, and also to collect information on the general system of farming practised. The report appeared in the French language some time after, under the title of 'Excursion Agricole à Jersey, par MM. J. Girardin, Professeur de Chimie à l'Ecole Départementale de la Seine Inférieure, et J. Molière, Professeur d'Agriculture du Département du Calvados.' In giving an account of their visit to Jersey, the writers dwell particularly on the varieties of apples used for cider-making, and the manner in which it is made, and observe that some of the cider which they had occasion to taste was far preferable to anything they had met with in France. On the rotation of crops they say:—

1st. A great proportion of land is devoted to the cultivation of roots and grass, or what is necessary for the maintenance of cattle.

2nd. That only one sort of grain (*i. e.* wheat) is grown.

3rd. That by growing so large a proportion of root-crops the soil receives the greatest possible advantage it can obtain, either in manure from the extra number of cattle kept, or in cleanliness from the great attention which root-crops demand.

4th. That the great variety of food given to cattle tends greatly to keep them in a better state of health.

5th. That by the system followed, a larger proportion of cattle can be maintained than by that which is followed in the northern departments of France.

In conclusion, they speak of the Jersey cow in the highest terms, and admit its pre-eminence for richness of milk over the best of theirs; for whereas in Jersey from thirteen to sixteen quarts of milk are sufficient to make two lbs. of butter, they admit that not less than twenty-eight quarts of milk of their best cows are required to make the same quantity. Whether it be through delicatesse or otherwise, MM. Girardin and Molière in their report throw out no suggestion on the art of farming which the Jerseyman might with advantage make applicable to himself: still I am led to believe that some changes might advantageously take place; for instance, among the list of imports is an item which formerly was one of the principal exports of the island,—I refer to the potato: of late years the farmer, anxious to grow varieties of this plant which would give a heavy return in weight per acre, forgot that it was necessary to maintain good quality, otherwise the sale of his produce would be lost. Now French potatoes are imported: true it is that as yet the quantity is small, but within two years it has increased rapidly, and from all appearances it is likely to become important; these potatoes are sold at a cheaper rate than those grown in the island, and their quality is preferred by many. No doubt that France can outvie the island in the cheapness of produce, but it should not be so in quality; let the Jersey farmer cultivate only the good sorts, and look to Covent Garden for their sale; backed as he is by Nature in every respect, if he but study early productiveness he can dispose of his produce at prices which will remunerate him far better than growing later sorts for foreign markets.

Before the existence of Free-Trade the Channel Islands were privileged, inasmuch as their produce entered the British ports free from duty, but at present they have to compete against all the world; and whereas corn was formerly exported to Britain, now on the contrary corn is imported into the islands; there is no doubt whatever that they have all suffered from the change; but it is singular that the value of land in Jersey has not diminished, the population has increased, and the demands for the island itself are great. On the subject of corn it is possible that much benefit might be derived by the introduction of new sorts of wheat. The "Velousé" and "Petit Blanc" have been known in the island for a very long period, since which, no doubt, new varieties have been raised that might with greater advantage be grown here; but on this, as well as on all that is connected with farming, the agriculturist is so bigoted and wedded to his ancient customs as to think improvement almost impossible.

Jersey Weights and Measures.

104 lbs. Jersey are equal to 112 lbs. English avoirdupois.
110 gallons „ 100 gallons imperial.

The Jersey measure for wheat, barley, oats, rye, potatoes, and apples is called "cabot," weighing as follows:—

	lbs. Jersey.
Wheat	32
Barley	40
Oats	28
Rye	40
Potato	40
Apple	38

Cider Measure.

2 pints	1 quart.
2 quarts	1 pot.
2 pots	1 gallon.*
60 gallons	1 hogshead.

Dry Measure.

$6\frac{3}{8}$ pints	1 sixtonnier.
6 sixtonniers	1 cabot.†
2 cabots	1 bushel.
8 cabots	1 quarter.
12 cabots of apples	1 quarter.

An English acre is equal to $2\frac{1}{4}$ Jersey vergées.

Jersey Market Prices.

	d.		d.
Beef, per lb.	7	to	8
Mutton „	6	„	8
Pork „	5	„	6
Veal „	7	„	8

For Exportation.

	£.	s.	d.		s.	d.	
Potatoes usually sell from	0	1	0	to	1	6	per cabot.
Wheat „	0	3	0	„	3	6	„
Apples „	0	5	0	„	12	0	per quarter.
Cider „	1	0	0		..		per hogshead.
Butter „	0	1	0	„	1	3	per lb.

The Jersey pound sterling is equal to 18*s.* $5\frac{1}{2}$*d.* of English coin, so that one English shilling is worth 1*s.* 1*d.* of Jersey money.

Guernsey.

Guernsey, the second in size of the Channel Islands, lies about 14 miles north-west of Jersey. In form it is triangular, or nearly so; its extreme length being $9\frac{1}{2}$ miles, and its extreme width $5\frac{1}{2}$ miles. In aspect a great difference exists between Guernsey

* The Jersey gallon contains 246 cubic inches.
† 9 wheat cabots are equal to 5 English bushels.

and Jersey; for whereas the latter slopes southwards, the former, on the contrary, on its southern side rises abruptly for several hundred feet above the level of the sea, and gradually inclines northward, until a little beyond its centre, where the fall rapidly increases, and it soon becomes a level plain; which in some places is actually below the water's edge. The whole surface of the island is computed at 15,000 acres; of these one-third may be said to be lowland, and the remainder to constitute the upper part of the island. In general, writers on the Channel Islands agree on one point,—which is, that the appearance of Guernsey is more barren than that of Jersey; this arises from the want of wooded scenery, for, although groups of trees may be seen immediately around the dwellings of the inhabitants, still it is not intersected by those deep and thickly-wooded valleys in which the sister island abounds; neither are there the same extensive orchards, nor the continuation of wooded embankments so common to Jersey, to the eastern district in particular; the rivulets also are smaller and fewer; but to make up for these deficiencies of nature, labour and art have successfully contributed.

The island is divided into ten parishes, namely:—St. Peter's Port, in which are the principal town and harbour; St. Samson's, with also a small town and good harbour; The Vale; Catel; St. Saviour's; St. Pierre du Bois; Torteval; Forêt; St. Martin's; St. Andrew's. In endeavouring to describe the nature of the soil, a great difficulty arises from the many varieties which exist on so small a surface. In what has been termed the Lowland may be comprised the parishes of St. Samson, the Vale, part of Catel, as well as a small portion of St. Peter's Port; the soil in these is inclined to lightness, but, owing to their position, sufficient moisture exists to make the land productive and equally valuable. This part of the island may be compared with St. Clement's parish, Jersey, and it is from this neighbourhood that the market receives its greatest vegetable supply. The soil on the rising ground assumes a stiffer appearance, and is said to be richest in the parishes of St. Andrew and St. Martin, although portions of Catel, St. Saviour's, and Forêt are equally good; the other parts are not considered of equal value. There, as well as in Jersey, the richest soil lies on a clayey bottom, beneath which are argillaceous schists and gneiss; but where granite exists, the soil becomes considerably lighter: the lowland is strictly granite, and the part of the island comprising the upper parishes is composed of gneiss, &c. It must be observed that, although in many parts the soil is very deep and rich, still, in these respects, it does not equal Jersey. With regard to climate much may be

said in favour of Guernsey: here as in the sister island the temperature is mild, and the air salubrious: plants, which in England are cultivated with care in greenhouses, will here be seen to thrive well in the open air; frosts are neither severe nor durable; and the heat of summer is tempered by gentle sea-breezes. The prevailing winds are from the west and south-west, except in the spring, when north-east winds sometimes prevail. The mean annual temperature of Guernsey is quoted at three degrees lower than that of Jersey. The annual fall of rain is about 36 inches.

With regard to property, the tenure is very similar to that before described; but there is one essential difference; it is—that, according to the law of succession, property becomes much more divided. A freehold is purchased in the same manner as in Jersey; it is paid for either in money or in rents. The system of rents differs, inasmuch as in this island they are due in corn, but, as the payment is more conveniently made in cash, the Court fixes every year at Easter the average price of the value of corn, and determines thereby the annual value of the rent per quarter.

In the division of property, the privileges of eldership are not so great as in the other island. In Guernsey little more than one-sixth of an acre is all that the eldest can claim with the house; he is also at liberty to keep possession of all lands to which he can have access without crossing the public road, but for such parts as exceed his own share he must pay to his co-heirs the price put upon it by the assessors of the parish in which the land is situated; in general, the assessments are made high, and it frequently follows that the eldest is compelled to waive all ideas of purchase. With the exception of one part of the land, which is reserved for the sons, and out of which has been taken the eldership, the real property is divided—two-thirds among the sons, and one-third among daughters; but should their relative numbers give an advantage to the daughters if a third were allotted to them, the sons, by waiving their claim to the point of land in question, may compel them to forego that advantage, and to share equally with brothers. From the extreme subdivision of land, farms are still smaller than in Jersey, none exceeding 40 acres; and the average may altogether be said to be at least one-fourth less in extent than in the last-mentioned island. The value is also much less: within a mile of town, land may be had for the annual rent of 5*l.* per acre; and in other parts of the island the usual price is 4*l.*, in many cases even less. The system of rotation is not particularly attended to, but the following is what is considered the old Guernsey course:—

1st year ..	Wheat.
2nd ,, ..	Parsnips.
3rd ,, ..	Wheat.
4th ,, ..	Barley and clover.
5th ,, ..	Clover.
6th ,, ..	Wheat. And so on.

Since the introduction of other root crops this system has given way; nevertheless, even at present, it is difficult to say precisely what is the general course followed: for on examination of various farms, it will be seen that in some portion or other the farmers differ from one another. As a rule this is perhaps the most common:—

1st year ..	Wheat.
2nd ,, ..	Parsnips and other roots.
3rd ,, ..	Wheat.
4th ,, ..	Oats and clover.
5th ,, ..	Clover (fed) and turnips.
6th ,, ..	Roots.
7th ,, ..	Wheat.

Turnips are not grown to any extent, nor yet carrots; but the principal root crops are decidedly parsnips and mangolds. Among cereals wheat is chiefly grown, but more oats and barley are cultivated than in Jersey. Certain fields and lowlands are laid down to permanent grass for hay, and only broken up and renewed when exhausted.

On a farm of 17 acres this has been found the usual distribution of crops:—

	Acres.
Hay and grass	$9\frac{1}{2}$
Turnips	$0\frac{3}{4}$
Parsnips	1
Potatoes	$0\frac{1}{4}$
Carrots	$0\frac{1}{2}$
Mangolds	$0\frac{3}{4}$
Wheat	$2\frac{1}{2}$
Oats and barley	1
Gardens, &c., where are grown cabbages and other vegetables	$0\frac{3}{4}$

On a farm of this extent the stock may consist of 4 cows, 6 heifers, 2 horses, 1 ox, and 6 or 7 pigs. In Guernsey oxen are much used for agricultural labour. Wheat is usually sown in the early part of January, and the manure applied consists of vraic ashes; the proportion being the same as in Jersey. The average produce of wheat is from $3\frac{1}{2}$ to 4 quarters per acre. The drill is becoming general for cereals, and the rate of seed sown per acre is about 68 lbs. The harvest takes place about the same time throughout the Channel Islands (August.) In this island the sheaves are made three times larger than in Jersey; this follows from the use

of the large reaping-hook, which is more common than in the other island. Wheat is extremely ripe when cut, so much so that a great deal is lost, and the following spring is often seen growing up with the clover. The stacking of corn is peculiar; the staddle is composed of only four stone pillars, with the frame resting on them; the stack is made up in a conical shape until it becomes so small that no more can be added; the summit is then thatched with straw. To strangers the effect of these is singular; but although the natives have seen the English and other modes, they are satisfied with their own; so much so as not to consider any change requisite.

The threshing of corn is precisely the same as before described. When the harvest is ended, the land is well covered with manure: stable manure is preferred, but when the quantity will not admit of its being entirely used up for one purpose vraic is substituted. For parsnips following the wheat-crop the manure is ploughed in sufficiently deep to ensure its being entirely buried. It is then left until the end of February, when it is again ploughed with the large plough, as in Jersey. The seed is sown broadcast, and the plants are cleaned of weeds three times during the season. The flat hoe is not used for the purpose, but a small square tool with a short handle,—so short that men are compelled to kneel on the ground when using it. In this island parsnips are much cultivated, and their properties much esteemed for cattle; 20 tons per acre are considered a good crop. Many oxen are fattened with this root, they are extremely fond of it and fatten rapidly; for pigs also it is used with the greatest advantage.

After parsnips, wheat again follows, but in this case the produce is considerably less than when following clover, mangolds, or turnips. Oats come next, sown in February, and, when of a certain size, clover is added for the following year. In produce, oats average about 5 quarters per acre. When the oats have been harvested, the clover springs up, and in the following summer is fed off; occasionally, if fine, it may be allowed to remain for another year, but, in the majority of cases, it is broken up in the early fall of the first year for turnips. The turnip commonly sown is the Purple-top Tankard; the Aberdeen is also grown, but only partially; as for the Swedish, it has become very unpopular, and is little grown, owing to its almost invariable failure. The yield of Tankard turnips is usually from 20 to 30 tons per acre. The rotation recommences with wheat, followed by roots, &c., as above mentioned. Mangolds are sown either in the second course (after wheat) or in the last, after clover. In Guernsey, mangolds yield from 40 to 50 tons per acre. The mode of ploughing, thinning, &c., is the same as

in the other island. Of late years (since the disease), potatoes have not been grown except for the wants of the island; some few are exported, but an equal quantity may be said to be imported. The produce per acre is considerably less than in Jersey. This valuable esculent also forms part of the second course with parsnips, &c.

Carrots have no fixed course; much depends on the land that can be spared for them. They are usually sown in March, and the produce per acre, when the crop is good, is not much less than 27 tons. The carrot is not a root which fills up much space on the farms of either island.

In consequence of its frequent tillage, the land is free from all weeds. It is a common rule, when a root or grain crop has been removed, to take a plough and skim the ground at once, the manure being in most cases first applied. Heavy manures are at all times used for mangolds, parsnips, &c.; but in former times, before these roots were cultivated to any extent, the fourth course, which was then barley, was that which received the heaviest dressing. Barley, when ripe, is seldom or never cut, but is pulled up by the roots and made into sheaves. Notwithstanding that several leading agriculturists have used their endeavours to check this, still the peasantry persevere in the practice, believing that it causes great benefit to the young clover growing in it. This system is the very opposite of that followed in Jersey, where it is observed that the harder you can keep the surface the better will be the crop in the ensuing summer. Hay is chiefly made from permanent grasses; these are dressed in the winter with short stable manure, which generally returns an abundant produce; but cattle do not feed upon hay made with these grasses so well as upon the clover and rye-grass mixed.

Vetches, as a crop, are more commonly cultivated in this island than in Jersey. They are usually followed by turnips, which yield a good return; in fact, it is after vetches that the finest are grown.

The farms being smaller than in the sister island, it naturally follows that the fields are also smaller in the same proportion: 1½ acres is fully the average size. They are also divided by large embankments of earth, on the top of which furze is seen growing luxuriantly; this furze is used by the country people for heating the oven for baking. At the field entrances you will rarely see gates, except on property belonging to the higher class. Very many field entrances are to be seen with only a bar placed across to prevent cattle from entering.

The dwelling houses are in general patterns of cleanliness. The exterior, in particular, presents a striking example of taste; flowers and creepers of various sorts invariably adorn the walls, the wood-

work appears as if it had been lately painted, and the ensemble is strikingly neat and pretty. The farm offices are not so large or well disposed as they might be, but, nevertheless, the inmates are comfortable and well attended to. Very little difference exists between the general arrangements of the farm-houses of either island. The different stables, sties, sheds, liquid-manure tanks, press-houses, &c., will all be found to have their allotted place. Cider is not so plentifully made as in Jersey, but the mode of making it is precisely the same.

The farm implements also vary little: the ploughs are more primitive in appearance, but they are considered to work well. The drill is on a small scale, but suitable to the size of the farms; its value is about five guineas. The spades are made after English patterns, with short handles.

With regard to stock, what has been said of one island is equally applicable to the other. The Guernseyman is as proud of his cow as the Jerseyman, and each feels satisfied that he possesses the pure and only genuine animal known as the Alderney cow. Although a great difference exists in the appearance of the animals, it is an open question which possesses the greatest merit. The Guernsey cattle are the largest of the Channel Islands breed, but for symmetry the palm is awarded to those of Jersey. The former does not vary so much in colour as the latter, but is usually red and white. The points which guide the Judges at the Royal Agricultural Society's Exhibitions are nearly the same as those used in the other island.

It is the custom here also to tether cattle when out. Cows calve usually in the early spring, and receive the same attention and food at that period as in Jersey; in short, the treatment and feeding at all times is perfectly similar. The produce may also be said to average about the same, for, although the greatest rivalry on this point exists between the farmers of both islands, on investigation it will be found that the accounts of produce correspond. The fattening of oxen is carried on here to a certain extent, and it may be computed that one-sixth of the supply is fed on the island. One of the great properties of the breed is that it will fatten rapidly, and produce meat of excellent quality.

The breed of horses is mixed, owing to the introduction of different sorts both from England and France. The farmer's horse is usually a small animal, calculated for all his work and not of any great value.

Pigs in general are fine, approaching in appearance a cross between the Hampshire and Berkshire breeds. They are fattened as in Jersey, parsnips being the principal food.

The management of the dairy differs from what has been

before described, inasmuch as it is here customary to churn the milk and not the cream. The churning takes place twice every week; the time occupied for making butter is, under the most favourable circumstances, $2\frac{1}{2}$ hours, never less, but often more than 3, and sometimes even the whole morning and afternoon, depending much on the temperature, which it is here said should be 68 degrees. The Guernsey butter is very good, but it remains a query whether more or better butter is obtained by this system of churning the milk. It is said that a trial once took place to test if, by churning the cream only, the same quantity could be made, and that it was found not to be the case; therefore the mode of churning the milk has been continued. If the temperature be too low, hot water is added until it arrives at 60 degrees at least; some churn at this, whilst others prefer a temperature of 68 degrees.

The following is an authentic statement of the exports of cattle during the last two years:—

	1857.	1858.
Oxen and bulls	51	41
Cows and calves	666	695

At the last census, taken in 1851, Guernsey contained 29,733 inhabitants. This population is differently composed from that in the sister island (Jersey): in the latter it was said that one-fourth were either English, Scotch, Irish, or foreigners; but here the proportion of strangers is comparatively small. Of country people there are three classes: first, the landowner, who possesses substantial property; secondly, the smaller proprietor; thirdly, the cottager. But the object which one and all have in view is the same throughout—viz. the acquirement of wealth and independence. The first class, having naturally the most means at their command, live on a more elevated scale than the rest: they have servants to assist in the rougher work of their occupations, and live at ease; but they invariably work themselves. The smaller proprietors do not employ servants, but do the entire work themselves; and by strict economy seldom fail to attain the object in view. In families belonging to this class many members turn their attention to trades, as well as to agricultural pursuits, and will occasionally snatch a day for the cultivation of their land; others may be fishermen, who devote their leisure moments to that calling. The third class consists of labourers, who, in most cases, having by industry earned sufficient to build small cottages on the patrimonial division which may have fallen to their lot, strive by their labour to increase their store.

Throughout the islands the manner of living is nearly the same. There are, perhaps, no people who rise earlier or retire

to rest later than the native farmers of the Channel Islands: it is not uncommon to hear of their being at work in the morning before four o'clock, and yet seldom is it that they take their rest before ten at night. The regular meals are—breakfast at half-past six o'clock, dinner at noon, and tea at six. The morning and evening meals consist of tea, bread, butter, and fish. In Guernsey it is common for the men, instead of tea, in the evening to substitute what there is called rôtie—this is made with cider and bread, &c. The dinner consists chiefly of vegetable soup and meat. At all times the beverage is cider.

To persons of a limited income the Channel Islands offer several advantages: the articles which are regarded as necessaries of life are considerably cheaper than in England. The climate also is a great recommendation; its mildness and evenness of temperature render the islands a very desirable abode, especially for invalids. Houses may be obtained at moderate rents, free from taxes of any amount. The markets are well supplied, and, last, but not least, no class of individuals can justly complain of the lack of good society. It has been said that, in Jersey, the spirit of independence is a marked trait in the native's character; here the same is found, though somewhat less sturdy; but in matters concerning the agriculture of the island they are truly devoted to their ancient customs—so much so, as almost to consider any change as detrimental to its interest.

Alderney.

Alderney is the nearest of the islands to either coast. The general appearance of the island is strictly barren: the absence of woods leaves it exposed to winds from all sides of the Channel, and the only shelter are the stone walls which here and there serve as enclosures. Although Alderney is more exposed, it is quite as healthy as any of the other islands. Of late years great changes have taken place in consequence of Government works, which are being carried out here on an extensive scale. The position of the island makes it the principal outpost, in fact, one of the keys of the Channel. Before these works were undertaken it was annually growing poorer, and the population growing less, for want of work. At the time of the last census, in 1851, the exact number of inhabitants was 3333. Of these, 1671 were natives, 1083 English and Welsh, 324 Irish, 156 French, and 99 Scotch. Ten years before the entire population scarcely exceeded 1000. The entire length of the island is said to be between three and four

miles, and its breadth one and a half miles. The soil is productive: it rests on grit, porphyry, and granite, but it is only of late years that much land has been cultivated. That part called the Braye is that which is most tilled; its appearance is singular, owing to the very minute properties, and the strange way in which the crops are sown: you will see long narrow stripes of different sorts of produce lying in different directions, and some of them so narrow that it is a puzzle to find out how the farmer can turn his plough. The small town of St. Anne comprises, with very few exceptions, all the houses in the island: and the want of houses scattered over the surface gives the island a deserted aspect. The agriculture of Alderney is certainly not equal to that of the other islands, though the land is good; it is chiefly light, but in some of the valleys becomes stiff. Formerly, before the increase of population, sufficient corn and other produce was grown for the maintenance of the inhabitants. There are three farms only which deserve notice; these are tilled as in Guernsey, and excellent crops of wheat and grass are produced. Vraic or seaweed is quite as much prized in Alderney as in either of the other islands for manure, its moisture being particularly adapted for the soil. The Alderney cow, of which so much has been said, is not unlike the animals in the other islands, in size only do they differ; their horns also are particularly small and curved in: about one hundred are annually exported. Horses are generally indifferent. It has been said of their pigs that many when fat will weigh as much as their well-fed cows. As in Sark, several of the inhabitants unite agriculture with fishing. The mode of life in Alderney is primitive, though not more so than in Sark or in some of the country parishes of the other islands. There are some few English resident half-pay officers, who here enjoy the quietude and happiness of life. A tolerable house may be had at from 10*l.* to 15*l.* a-year, and meat and poultry are somewhat cheaper than in Guernsey.

In concluding these remarks, a few words may be said of the constitution of Alderney. It consists of an assembly called the States, and of a Court of Judicature, which, however, has no power in criminal cases, all such being tried in Guernsey. The States are composed of six jurats, named by the ratepayers, and of a president named by the Crown, and also of the douzainiers, who are consulted, but have no vote. In reality, the States and Court are the same body.

SARK.

The small island of Sark lies about six miles eastward of Guernsey; its length is about three miles, and its width averages about one mile. The island is divided into two unequal portions, which are known by the name of Great Sark and Little Sark. The island is a table-land, with few valleys, having no declivity to the sea at any part, except a trifling one at the northern extremity: it is surrounded by a barrier of cliffs rising from 200 to 400 feet above the level of the sea. To the visitor the first impression of Sark will be that it is barren. The peninsula of Little Sark is connected with the other portion by a narrow isthmus known as "La Coupée:" this is a very narrow and lofty ridge; its length is about 450 feet, and its width varies from 5 to 8 feet: perpendicular cliffs of about 300 feet on the eastern side, with shelving and broken rocks on the western, give it a terrific appearance. As this narrow ridge forms the only communication between the two portions of the island, all classes of its inhabitants, both young and old, are obliged to pass it.

Sark contains a population of between 800 and 900 persons, a number much less than the island could support, but the increase of the population is checked by the manner in which the land is held.

The fertility of the soil is considered even greater than in Jersey or Guernsey. Sark is also the richest of the Channel Islands in minerals; the working of silver-mines was carried on briskly at one time, but is now discontinued. As has been said, the soil is very fertile, and vegetation begins at the point where mineralisation ceases. The main rock of the island is gneiss, and on its northern and southern extremities it is tipped with granite. The mode of farming is carried on somewhat after the Jersey system; the agricultural implements are more rude, but the same rotation is observed; and although Sark is a smaller island than Alderney, its agriculture at present is far before it. The principal and most abundant products are wheat, barley, oats, and parsnips; the exportation of grain to Guernsey, and the fattening of oxen, form the mainstay of the farmer. Remains of the ancient feudal system still exist, but the most singular feature is the law concerning the possession and division of property. There are forty copyhold possessions in the island; no copyholder can sell or dispose of a part of his property: he may sell the whole, but in that case one-thirteenth of the purchase goes to the lord of the manor. In case of death the property devolves wholly upon the eldest son, and, should there be no son, to the eldest daughter, or, failing such, to the eldest collateral branch. In short, all properties must continue entire

as originally granted. Widows during their lifetime enjoy one-third of the entire property. About 800 acres of land are in cultivation, and it is computed that two-thirds of the produce are exported. The soil is a very rich loam, extremely well adapted for root crops; the principal root grown is the parsnip, which is employed for fattening oxen and pigs; the manure employed as in all the other islands is seaweed. The cattle here are not so much thought of as in the other islands, nor is the same attention paid to them. The horses are small and rough, not unlike mountain ponies, and the native sheep are singularly small. Cider is also manufactured to a certain extent, but for quality little can be said in its favour. In Sark almost every proprietor possesses his boat, for the Sarkese all turn their attention to fishing, and every article which is not the produce of the island has to be imported from Guernsey.

Altogether Sark is a remarkable spot. The lord of the manor is the sole impropriator of tithes; he receives the tenth sheaf of wheat, barley, oats, peas, and likewise the same of wool and lamb. Sark forms part of the bailiwick of Guernsey, and is under its jurisdiction in civil, military, and ecclesiastical matters; but the local management is vested in the Seigneur and his forty tenants, who together compose an Assembly, which sits three times every year.

Little can be said of Sark in an agricultural point of view; the farms are small, and the system which they follow is the same that was introduced by its early inhabitants, who were natives of Jersey. The island was ceded by Queen Elizabeth to Helier de Carteret, one of the members of the St. Ouen family, Jersey, for services rendered to his country. The inhabitants being exclusively engaged in fishing and agriculture, it is not to be wondered at that solitude should have proved an obstacle to improvement. The natives do not differ from their ancestors in customs and manners, but continue to pursue their course through life in the same way. It is a fact worth mentioning that the jail of Sark is rarely tenanted. The people are well-disposed, and have few temptations to immorality.

It has often been thought by visitors that, if building leases were granted for a long date on certain parts of the seignorial estates, the value of property would be enhanced; but persons better acquainted with the minutiæ of the island are of opinion that the prosperity of Sark would end, should the law on landed property be altered.

Beaumont, Jersey, 1859.

V.—*Beet-root Distillery.* By F. R. de la Tréhonnais.

The cultivation of root crops, wherever it has been adopted as one of the elements of the rotative course of husbandry, has never failed to achieve a most remarkable improvement in agriculture, not only as an immediate and profitable source of production to the farmer, but also as a powerful means of bringing the land to that desirable state of cleanliness and comminution of tilth, without which manures are powerless in the soil, and the natural elements of fertility which the soil may possess, unavailing.

In England the necessity of an increased supply of fodder for improved breeds of cattle has made the cultivation of root crops one of the most lucrative operations of husbandry: inasmuch as its immediate result is the production of meat, dairy produce, and manure, the market value of which is not only steady, but gradually increasing; whereas the price of cereals is fickle beyond human control, continually ascending or descending,—between extreme dearth too abnormal to last, and extreme cheapness ruinous to the producer. It may then be asserted that the production of beef and mutton is the pivot upon which the whole system of English agriculture revolves. Since the repeal of the Corn Laws the London market has become the cereal mart of the world; and the price of wheat in England is not so much regulated by the accidents of scarcity or plenty at home, as by the same accidents all over the world. If the wheat crop has failed in cloudy England, it does not follow that the English farmer will find in the enhanced price of that commodity a compensation for the deficiency in the produce of his land; the cheering beams of plenty are shedding joy and riches in more favoured lands, and the reflection of foreign harvests is permitted to shine upon free England.

Although the cultivation of root crops has furnished the English farmer with the means of combating the effect of an unshackled foreign competition in corn upon his own market, by enabling him to feed a larger supply of beef and mutton, it does not follow that the same happy results would be a sufficient incentive in France, for instance, to lead to the adoption of that cultivation; for it is obvious that the beneficial results of that culture would by no means be identical. English breeds of cattle have been so much improved within the last fifty years in their precocity and wonderful aptitude to fatten, that the time they have to remain in the feeding-stall has been reduced at least by half, as compared with continental breeds. A bullock when two years or two years and a half old; a sheep at twelve or fourteen months; a pig at nine months, are sent to the shambles, and realized in hard cash. Whereas periods of twice,

and in many cases three times, that length are necessary to bring continental breeds to the same weight and degree of fatness; and this means three times more expense in food, and three times more capital engaged, with a proportionate loss of interest.

These preliminary considerations naturally lead me to the subject of this paper—viz. *beet-root distillery.* In this and other subjects equally important connected with agricultural practice in France, lies the problem of the application of purely manufacturing operations to agriculture. Hitherto, and especially in England, agricultural pursuits have been exclusively confined to the production of the raw materials of food and raiment. But the question arises, whether the farmer could not advantageously bring his goods to market in a more elaborate form—for instance, flour instead of corn, beef and mutton instead of live stock, bacon instead of pork, flax instead of flax straw, &c. &c.? Being obliged to have recourse to steam-power for many farm operations, it is not unreasonable for him to aspire to a more extended use of a motive power now become indispensable; but as these points are somewhat foreign to my subject, I mention them merely as a ready illustration of the idea of adapting manufacturing processes to agriculture, which seems now to prevail in France in so remarkable a degree.

There are many peculiarities in French agriculture which render the adoption of English principles altogether impossible. The nature of the climate, the peculiarity of the soil, the wants of the population, and the requirements of French commerce, have strongly influenced the cultivation of the land, and rendered manufacturing operations a matter of necessity to the farmer. In at least one-half of France vines are cultivated, and the tiller of the soil makes his own wine upon his farm premises. In the south he cultivates the mulberry tree, feeds silkworms upon his farm, and produces raw silk. Tobacco, several tinctorial plants, hemp, flax, olives, poppies, colza, and other oleaginous vegetables, cover a considerable portion of the arable land; and in many instances most of these plants are used as raw materials upon the farm premises, and sent to market ready for consumption. Everybody knows how the first Napoleon created the manufacture of sugar from beet-root. What was then a necessary expedient, has become in our times an important branch of industry and a powerful stimulant to agricultural progress, by introducing the cultivation of root crops into the routine of French agriculture—the happy results of which are so conspicuous in the North of France and Belgium, where the land is better cultivated and more productive than in any other part of the Continent.

The grape disease, which, like the potato blight in Ireland

and elsewhere, has so mysteriously scattered ruin and desolation throughout the vine districts of France, has given birth to another manufacturing operation, readily adapted to the farm,—I mean the distillery of beet-root; and the question I have now to examine is, whether that operation ceases to be advantageous with the dire necessity that gave it birth, or whether it may be classed as a lucrative adjunct to agricultural pursuits, easy in its operation, and at all times attended with ultimate profit? My present object is to examine the bearings of this problem, by faithfully and impartially reproducing the arguments of both parties, in order that every one may form his own conclusions from the facts I shall bring forward; for it must be understood that the advantages of beet-root distillery are by no means universally admitted in France: it is still the subject of controversy; and, as is generally the case when arguments are influenced by the excitement of partisanship or the heat of discussion, it is not an easy task to disentangle truth from error.

The cultivation of beet-root is chiefly confined to the North of France and the neighbourhood of Paris. In these districts there are several departments where it forms the staple of agricultural produce, principally for the manufacture of sugar; these are: the *Pas-de-Calais*, *Nord*, *Aisne*, *Somme*, and *Seine-Inférieure.* In the departments of *Oise*, *Seine*, *Seine et Oise*, *Seine et Marne*, mangolds are cultivated exclusively as food for cattle, as they are in England; and it is principally in these districts that the beet-root distilleries have been established. Beet-roots, together with carrots, are also cultivated in other parts of France, but more as an exception than as a rule. In the South, for instance, it is alleged that the climate is too dry; although, in a recent tour through the whole of the southern districts of France, I have seen fields of mangold, remarkable for the luxuriance and freshness of the foliage, and comparative size of the root. I imagine that by the use of superphosphate of lime, which, by-the-bye, does not seem to be better known in France than guano was in England fifty years ago, crops of mangold could be grown in almost every part of the South of France, especially in that magnificent plain extending from the ocean to the Mediterranean,—which includes the valleys of the Garonne and the Lot, and, in fact, the whole district traversed by the Grand Junction Canal from Cette to Bordeaux. The virgin savannahs of the New World can alone bear a comparison with the luxuriance of that rich plain through which flow the Garonne and its lateral canal; and yet it must be confessed that the crops are by no means equal to the natural fertility of the soil, owing to want of drainage, shallow cultivation, and general ignorance.

In those districts of the North of France where sugar manu-

factories exist, the kind of beet-root generally cultivated is that known under the name of *Silesian.* Its mode of cultivation does not greatly differ from that pursued in England. The soil is broken up soon after harvest by a shallow ploughing. During the autumn and beginning of winter manure is carted upon the land, whenever the wheat-sowing will allow. Sometimes the manure is put in by a very shallow ploughing, which merely covers it with a thin layer of soil; and then, in the midst of the winter, it is further buried to a depth of at least ten inches. Early in the spring, as soon as the weather will allow, the surface is comminuted with repeated harrowing, clod-crushing, &c. The harrows generally used are made of wood, but iron ones are gradually getting into use. The time of sowing is between the 15th of April and the 15th of May. After sowing, the land is heavily rolled. The seed is generally drilled in rows 20 inches apart. As soon as the plants appear, and the lines are clearly discernible, the field is horse-hoed, in order to eradicate the first weeds. A few days later, when a second crop of weeds has grown, the intervals are again horse-hoed; and then come the hand-hoe and the labourer's hands to thin and single the plants, &c.

The land is generally so foul in France, and, for want of the application of stimulating manures, the growth of the young plant is so slow, that frequent hoeings are required, in order to keep the plant from being smothered.

The majority of farmers, who have no horse-hoes, are obliged to use the hand-hoe, and thus four distinct operations are necessary.

The first, when the lines are visible, to destroy the weeds between the rows.

The second, when the plants have four leaves, to thin and isolate the bunches.

The third, to finally single the plants, clear away the weeds, and loosen the soil.

These operations take place from the end of May to the end of June.

The fourth operation clears the crop of the last weeds; this takes place in July.

The average cost of these four operations is about 17*s.* 3*d.* per acre:—the first costing about 2*s.* 9*d.*; the second, 6*s.*; the third, 5*s.*; and the fourth, 3*s.* 6*d.*

Mangolds are pulled off in October and the beginning of November; they are then stored in heaps partly sunk in the ground, and covered either with straw or sods. The pulling off and loading in the waggons costs about 12*s.* per acre.

The sugar manufacturers have an interest in commencing their operations early. They generally press the farmers, with whom they enter into contracts, to begin delivering the roots from the

latter end of September; but this request is seldom complied with, as there is a saying that the root makes its weight in October. The delivery seldom commences before the 10th of October, and by the 10th of November all the crop must be under cover.

The place occupied by the cultivation of mangolds in the rotative course of French agriculture varies according to the pursuits of the agriculturists. If the farmer is a sugar manufacturer, the breadth of roots he cultivates is naturally larger. In that case it occupies about two-fifths of his farm; two-fifths are under white crops; and one-fifth under seeds. If, on the contrary, the farmer is not a manufacturer, he cultivates roots only as an element of the four-course rotation, and follows pretty nearly the same system as is usual in England, with this difference, that, as turnips are not cultivated in France, mangolds exclusively fill up the space allotted to both crops in this country.

Owing to the want of proper manure, such as superphosphate and salt, and also to the imperfect manner in which the land is prepared, the average crop of mangold is not near so heavy in France as it is in England. In soils naturally fertile, or well tilled and abundantly manured, 25 tons of roots per acre are considered a very heavy and unusual crop; but the average does not certainly exceed 16 tons per acre in the northern departments, and 12 tons elsewhere.

The price usually paid by the sugar manufacturer has lately varied much. When the beet-root distilleries were flourishing, that is, when the vine disease had greatly enhanced the price of alcohol, mangolds were readily bought at 24*s.* a ton; before that period the price did not exceed 12*s.* In 1857 the price was 20*s.*; in 1858, about 16*s.*; and for 1859, 16*s.* are now offered.

The pulp from which the saccharine juice has been extracted is equal to about 24 per cent. of the weight of the roots, and is considered better and more nutritive than an equal weight of roots for cattle. The manufacturers sell the pulp at about 12*s.* a ton, and it is readily bought at that price by the neighbouring farmers, who bring it back in their carts on their return from taking the roots to the factory.

In those districts where there are no sugar manufacturers, the species of mangold cultivated is the yellow globe; it is there solely used as fodder, either raw, in which form it is generally cut up and mixed with chaff, or else macerated, fermented, or boiled, and then mixed with clover hay, vetches, oilcake, or the refuse of the mill-stones, such as bran, husks of grain, &c.

The climate of the beet-root districts does not materially differ from that of England. The temperature in winter ranges between 4° below zero up to 14° above (centigrade), equal to 25° to 57°

Fahr.; in summer generally from 12° to 18° (54° to 64° Fahr.); the extreme being 30° and sometimes 32° (86° to 90° Fahr.). In autumn the temperature is generally mild, and ranges from 2° to 12° (36° to 54° Fahr.); but often in November there are sharp frosts, when the temperature comes down as low as 6° below zero (21° Fahr.). Spring is also frequently cold and sharp. The average fall of rain is about the same as it is in the central part of England.

Having thus given a general outline of the conditions under which mangolds are cultivated in France, I will proceed to describe the operation of distilling, with the most authentic results, which personal inquiries made during a recent journey to France have enabled me to gather.

The existence in mangolds of substances from which alcohol could be extracted by distillation has been known for many years, but it was only under the impulse of the high price of spirits resulting from the vine disease, and the prohibition by the French government of the distillation of grain in the year 1854, owing to the scarcity of corn, that this principle began to receive a practical application. In 1854-55 many sugar manufacturers, instead of making sugar, turned to the distillation of beet-root, for the value of alcohol had reached the unheard-of price of 177 francs per hectolitre, or, in English figures, about 6*s.* 6*d.* a gallon. The substitution of the production of beet-root alcohol for that of sugar in the winter 1854-55 created in the sugar-returns no less a deficiency than 40,000 tons, and it is calculated that the quantity of alcohol that was distilled instead, reached at least 3½ millions of gallons. It is therefore not surprising that farmers should have turned their attention to so profitable a mode of disposing of their produce, and even at that early period of the history of beet-root distillation no less than one million gallons of beet-root spirit were produced from agricultural stills. Notwithstanding this great supply from a source hitherto neglected, the deficiency in the usual sources of production from the wine district was so great, that, in order to meet the demands of French home consumption and export commerce, immense quantities of raw spirits were imported from this country. It is calculated that during the year 1855 no less than 2,200,000 gallons of spirits were imported into France, chiefly from England.

As long as this abnormal state of the spirit trade lasted, the system of distilling alcohol from beet-root, considered as a branch of agricultural industry, and carried on by the farmer upon his farm, found no detractor, for the advantages were undeniably great; but when the market reassumed its previous condition, and the price of alcohol returned to its ordinary limits, there arose the question whether or not that operation really was an advantage to agriculture, and many inquiries and calculations

were made to prove or disprove that proposition. Before I enter more fully into the merits of the case, I will briefly describe the very simple process now used in France—a process known by the name of the inventor and patentee, M. Champonnois.

The apparatus necessary for the distillery is neither expensive nor intricate. It simply consists of two or three tubs for soaking the slices, four tubs for fermenting, and an ordinary still.

The roots are first cleaned and washed, then sliced in the usual way into longitudinal pieces. These are placed in the soaking-tubs with hot water, to macerate. The object of that process is to dissolve the saccharine matter, and separate it from the cellular tissue of the root. This operation lasts about an hour. The hot slices are then removed, and carted away as pulp for cattle. The pulp loses by maceration from 20 to 25 per cent. of its weight; which represents the amount of saccharine juice obtained. This juice is run into the fermentation-tubs, where it remains 24 hours, and is then passed through the still in the usual manner.

There are in the Champonnois process several points which greatly recommend its adoption, from their simplicity and economy. For instance, the hot water necessary to the maceration of the slices is supplied after the first day from the residue of the still, that is, the juice itself minus its alcohol. This juice when removed from the still has a sufficiently high temperature to macerate the roots, and thus effect a great economy of fuel. By this plan, whatever nutritive substance may remain suspended in the juice after the alcohol has been removed, is not wasted, but is again absorbed by the pulp; so that in reality the root has lost nothing of its constituents except the alcohol producing sugar.

Another important feature of this system is what is called the continuous fermentation. Formerly to produce the necessary fermentation in each tub it was necessary to add each time a certain quantity of beer-ferment or yeast. This not only occasioned a certain expenditure, but also great irregularity in the fermentation. The system of continuous fermentation consists in running, without any interruption, fresh juice from the macerating into the fermenting tubs, already filled with juice in a fermented state; so that the decomposition of the saccharine matter and its consequent transformation into alcohol is continuous, and by the time it reaches the fourth tub the fermentation is complete, and the juice is ready for the still.

We have now to consider the following points:—

1. The yield of alcohol.
2. The cost of the process.
3. The nutritive value of the pulp.

The first and second points are easily disposed of. The French Imperial Society of Agriculture has fully investigated the subject, and the report of the Committee appointed in 1856 is sufficiently accurate to determine with certainty the average yield of alcohol and the cost of the process. The Committee appointed by the Society consisted of men whose names are well known in the scientific world, and are a sufficient pledge of the value of their observations and the accuracy of their conclusions. Among them we find such men as Boussingault, Payen, Baudement, Yvart, Pasquier, Delafond, &c. It is, then, with entire confidence that I take from the report read by M. Baudement before the Society on the 6th of August, 1856, the following particulars.

The Committee visited eighteen distilleries, and found that the average percentage of alcohol amounted to 4·19; and since that investigation took place nothing has occurred in the practice of distillers to impugn that conclusion. It follows, then, that it takes 2 tons 6 cwts. 3 qrs. of roots to produce an hectolitre of absolute alcohol (*i. e.* of the strength of 100 degrees), equal to about 22 imperial gallons.

The expenses attending the management of the Champonnois process of distilling amounts to 6s. 5½*d.* per ton of roots, divided as follows:—

	£.	*s.*	*d.*
Fuel	0	1	3
Labour and various expenses	0	3	6½
Interest and repairs	0	1	8
Total	0	6	5½

So that the cost of producing an hectolitre or 22 gallons of spirits rectified to 100 degrees amounts to about 15*s.* 6*d.*, or about 8½*d.* per gallon. But to this cost must be added the difference between the value of the beet-root before and after maceration, that is between the raw mangold and the pulp.

This is the turning point where continental agriculturists begin to differ, and the question is sufficiently difficult to demand extreme caution and prudent reserve in its handling.

To come to a right estimate we must begin by ascertaining the money-value of a ton of roots. We know what value in alcohol it will yield by distillation; we know the cost of the process, because these items can be easily and accurately determined; but not so with the cost of a ton of mangolds, because the circumstances by which its production is attended are so varied and so much mixed up with other accounts, that it is next to impossible to ascertain its cost with anything like certainty. There are two ways of making the calculation; one by ascertaining the

cost of production, which, as I have just stated, is next to impossible—the other by taking as a basis the selling price of the roots. Of the two the former would of course be the most satisfactory, for the selling price of any goods is by no means a criterion of their intrinsic value; but I will take the latter as the only one available. It may be assumed that the average market-value of beet-root in France, taking the range of the last six years, is about 14*s.* per ton. The cost of manipulation being, as we have seen, 6*s.* 5½*d.*, it follows that the quantity of alcohol extracted from one ton of mangolds costs 20*s.* 5*d.* But from this amount must be deducted the value of the pulp; and here is another difficulty which has become the theme of very angry discussions in French agricultural papers—What is the proportionate value of the pulp as compared with the root? A great many experiments have been made by the partisans of distilleries; and if we were to accept the conclusions they have drawn it would appear that pulp is equal in nutritive qualities to the roots themselves, weight for weight. I shall presently refer to some of the experiments that have been made, in order to give an idea of the manner in which they were conducted. Nearly all the distillers visited by the French Committee from the Imperial Society stated that from their experience the pulp was equal to the roots. Thus, out of eighteen distillers examined, five were of opinion that the pulp is superior to the root; five gave no other opinion but that pulp is an excellent food for cattle; two thought the pulp equal to the root; two considered the pulp inferior to the root by at least 25 per cent.; one other declared pulp superior to many other kinds of fodder, without specifying which; another said he preferred pulp at 9*s.* 6*d.* a ton to beet-roots at 16*s.*; others gave no reply. The average value of these answers would lead us to the conclusion that a pound of pulp is equal to one of root in nutritive quality—a fact which requires confirmation by further experiments, and which, at all events, cannot be established by the mere assertion of the distillers. But, whatever the difference may be, it is certain that pulp is a valuable food for cattle, and that, if it has lost some of its nutritive elements by the process of maceration, that loss cannot be considerable. It is further proved that pulp is exceedingly palatable to cattle, who eat it with avidity. It is also easy of digestion, and when mixed up with chaff, oil-cake, or any farinaceous food, it forms an energetic element of fattening. M. Baudement, in his very clever report, gives a value of 7*s.* 3*d.* to the quantity of pulp produced by a ton of roots after maceration, which being deducted from 20*s.* 5*d.*, there remains, as the net cost of the alcohol extracted from one ton of roots, the sum of 13*s.* 2*d.*; and, consequently, the cost of one gallon of alcohol would stand at about 1*s.* 7*d.*

This figure, however, does not represent the actual cost of a gallon of spirit fit for the market. When it comes out of the still it contains a certain quantity of essential oils, and about fifty per cent. of its bulk of water. This mixture is known under the name of *Flegme*, and must either be rectified or sold in the market as it is. The process of rectification up to ninety-four degrees, the usual strength of alcohol in the market, adds about 9*d.* to the cost of a gallon of spirit distilled from beet-root, which gives us a total of 2*s.* 4*d.* per gallon. So it may be assumed, that whenever the price of spirits will allow a profit upon that cost, there is an advantage in distilling; when otherwise, there is a loss.

And yet there are certain distillers who contend that, at whatever price alcohol may be, there is always an advantage to the farmer in taking his roots to the feeding-stalls by passing them through the distillery. Such warm partisans of the system maintain that part of the expenses charged to the distillery would be incurred if the roots were given directly to the cattle. For instance, the roots must be washed, sliced, and, as is generally practised, boiled; so that in both cases these preliminary expenses would be the same; and the only difference would then be the loss of nutritive elements by distillation. In effect, the sugar has been abstracted and turned into alcohol; but, to use the expression of one of my informants, the sugar abstracted from the roots is safely stored in casks as alcohol for the market; and experience proves that the value of the quantity of alcohol thus abstracted from the roots is greatly higher than that of the quantity of nutritive elements lost in the roots by the process. Then arises the question, whether alcohol is a necessary ingredient of nutrition, and therefore, whether the pulp in losing its sugar has lost any important constituent of its nutritive qualities? These are questions which I would not presume to solve without making careful experiments, which, I understand, are now being made by Mr. Voelcker at Cirencester. But assuming that, weight for weight, pulp is equal to roots, it must be admitted that the distiller's reasoning is a plausible one, and deserves the serious attention of agriculturists in this country.

There is another point which must not be lost sight of. I have stated that the roots lost by maceration about 25 per cent. of their weight; but we have seen that the raw spirit on its exit from the still contains 50 per cent. of water,—so that a large proportion of that loss of 25 per cent. in the weight of the roots must be mere water. At all events, it is very clear that pulp cannot, any more than roots, constitute a complete food for animals. Neither possesses all the requisite constituents of nutrition and fattening; they must of necessity be mixed up with other ingre-

dients generally produced upon the farm, and which, being likewise incomplete as to their nutritive qualities, are thus rendered useful from being mixed up with the pulp.

Mr. Bella, the learned Director of the Agricultural College of Grignon, made, some years ago, some valuable experiments upon the feeding qualities of pulp, and its hygienic effects upon cattle. From these he concluded that the transition between the ordinary *régime* and the feeding with pulp must be carefully managed, and that animals, on leaving the pulp *régime*, experience a greater difficulty in passing to another kind of food, than when leaving the ordinary system to adopt the pulp *régime*.

These experiments were carefully made; and in order to give a clear idea of the objects Mr. Bella had in view, I will annex, as an appendix to this paper, a full report of one of these experiments made upon two milk cows, together with others made upon sheep.

It would appear, from all the experiments made in France, that pulp as food is better suited to fattening than to breeding stock.

M. Delafond, Professor at the Veterinary College of Alford, and a Member of the Committee appointed by the Imperial Society, made an additional report upon the use of pulp in feeding cattle; from which I will extract a few passages, which will throw some light upon its effects upon the health and fattening of animals, the secretion of milk, &c.

The temperature of the slices after maceration is about equal to that of boiling water. They are removed to a suitable place, there to be mixed up with chaff and various other ingredients, in order to absorb the juice which might flow away. Then the mixture is thoroughly made with a wooden shovel; fermentation sets in, and maintains a certain heat for at least twenty-four hours. The mean temperature is equal to about 35° centigrade (95° Fahr.).

The analysis of pulp shows that it contains from 87 to 90 per cent. of water; compared with the roots, it is found deficient in sugar only, although it still contains a certain quantity of it. It possesses all the organic constituents of the root, besides some organic acids and some earthy saline substances derived from the soil adherent to the roots. The subsequent fermentation which arises in the mixture of hot pulp with chaff, oil-cake, &c., produces, besides, a certain quantity of alcohol, and, perhaps, also some volatile oils, yielded by the rape-cake and the hay. The chaff, and especially the oil-cakes, contribute also to the mixture a large proportion of fatty matter. This mixture, when made in suitable proportions, according to the age, the kind, the breed, &c., of the animals, will always provide a suitable food to fill the stomachs of ruminants without overloading them,

and furnish the constituents necessary for the growth of young animals, the preservation of a healthy condition, and the fattening of cattle. I quote here from the Report:—

"The fermented mixture containing a noticeable quantity of water possesses all the conditions necessary to the nutrition of ruminants; it necessitates mastication, and produces a sufficient salivation to facilitate rumination and digestion. It gets into the rumen at a temperature of from 30 to 36 degrees (centigrade), or almost the temperature of the body, and thus it does not cool the digestive viscera. This mixture, then, has not the fault of dry nutritive matters, which always require an abundant salivation, and always need to be warmed in the rumen."

From this consideration, Mr. Delafond thinks that pulp thus prepared is to be preferred to mangold, turnips, carrots, potatoes, &c., given raw and in an unfermented state to cattle. He thinks, further, as an important consideration, that the nutritive matter thus prepared and fermented softens and penetrates dry substances,—such as the husks of corn, the leaves, the stems, and the seeds; which thus become easier to ruminate and digest. He remarks also, that the acetic, lactic, pectic acids, together with the *vinasse*,* appear to favour digestion, and render it more rapid, and thence more profitable. Besides, the animals, finding in the fermented preparation a quantity of water almost sufficient to quench their thirst, scarcely drink anything, and thus avoid introducing into their stomachs a quantity of cold water, always considerable, and so much greater in proportion as the food they take is drier. These injections of cold water, by cooling the rumen and overloading it, frequently cause terrible indigestions, which not unfrequently end in death.

I am not aware how far the fermentation system of feeding cattle is practised in this country. I have never met with it in any of the many farms I have visited; and I think, from the beneficial results obtained from that system in France, where it is generally adopted, that it deserves a trial in England; for if it should be found advantageous, it would undoubtedly be a powerful inducement to attempt the distillation of mangolds.

But here arises the question whether the roots grown in England possess the same constituents, or, at any rate, the same proportion of saccharine matter, as those raised upon French soil and under the influence of French climate. Chemistry alone can give an answer to this. With this view, I will therefore examine various analyses made in France and in England by men of unquestionable merits and abilities.

There are several kinds of beet-roots, and all are not equally suitable for the production of either sugar or alcohol. I have

* Name given to the dregs of the still used to macerate the sliced roots.

already stated that the kind preferred by the sugar-manufacturers is the white Silesian, with green or pink necks; and it would appear that these varieties are also the best for the still. If the exclusive object of the distiller were the production of spirits, no doubt but the variety of beet-root containing the largest quantity of saccharine matter would be much better suited to the purpose of his industry than any other. But we must not lose sight of the consideration that the object of this paper is not to treat of beet-root distillery as an abstract manufacture, but as a branch of agricultural economy; and therefore we have two things to consider: one that is paramount, and constitutes the principal aim of the operation—I mean, the production of food for the live stock of the farm; and the other, which may be regarded as a mere accessory—the production of alcohol. It is then a matter of importance to consider whether the cultivation of the variety of beet called yellow globe, although evidently not so rich in saccharine matter, is not, nevertheless, more advantageous to the distilling farmer, on account of its greater yield in bulk per acre.

Let us, therefore, compare the average yield of an acre of sugar-beet, and its value in alcohol and food for cattle, with that of an acre of yellow globes.

In France the average crop of Silesian beet-root does not exceed 12 tons per acre. Taking the average yield of alcohol at 4·64 per cent., and the decrease in weight effected in the pulp by maceration at 24 per cent., one acre would produce about 129 gallons of spirits and about 9 tons of pulp.

We have seen that the cost of working a ton of roots amounts to 6*s.* 5*d.*; the 12 tons will then cost 3*l.* 17*s.*, and the gallon of unrectified spirit a fraction more than 7*d.*

On the other hand, the average yield of yellow globes is fully 19 tons per acre, yielding only 3·43 per cent. of alcohol and 76 per cent. of pulp: this would give in pure alcohol 143 gallons, and 14½ tons of pulp: the cost of working 19 tons at 6*s.* 5*d.* would come to 6*l.* 1*s.* 11*d.*, which would bring the cost of distilling one gallon of spirit to 11*d.*

The balance-sheet will stand thus for the two crops:—

Sugar Beet-roots per Acre.

	£.	s.	d.
129 gallons of spirits at 1*s.*	6	9	0
9 tons 2 cwt. of pulp at 10*s.*	4	10	0
	10	19	0
Less cost of manipulation	3	17	0
Balance of profit	£7	2	0

Yellow Globe per Acre.	£.	s.	d.
143 gallons of spirits at 1*s.*	7	3	0
14 tons 10 cwt. of pulp at 10*s.*	7	5	0
	14	8	0
Less cost of manipulation	6	1	11
Balance of profit	£8	6	1

From the above calculations it would appear that the farmer would get 1*l.* 4*s.* 1*d.* more per acre by cultivating the yellow globe, although less rich in saccharine matter.

I will now compare an analysis of French-grown beet-roots, made by my friend M. Baudement, the learned Professor of Zootechny at the *Conservatoire des Arts et Métiers*, in Paris, with one of English-grown mangolds, kindly communicated to me by Professor Voelcker, of Cirencester.

Analysis of French-grown roots, by Professor Baudement, of Paris:—

Yellow Globe.

Water	86·89
Ashes {soluble 0·65, insoluble 0·595}	1·245
Fat-producing matters	0·1269
Nitrogenous, or flesh-producing matters ..	1·3713
Insoluble matters, such as cellulose, ligneous	1·078
Sugar, gum, and mucilage	9·2888
	100·

Analysis of English-grown roots, by Professor Voelcker:—

Yellow Globe.

	Detailed composition of two samples.		
Water	87·440	..	88·450
Sugar, gum, and mucilage	7·408	..	7·469
Soluble mineral matter	1·356	..	·952
Soluble albuminous compounds, containing nitrogen ·153 ..	·956	nitrogen ·155	·887
Insoluble albuminous compounds, containing nitrogen ·023 ..	·144	nitrogen ·017	·104
Cellular fibre and pectinous substances (crude fibre) ..	2·583	..	1·995
Insoluble mineral matters	·113	..	·074
	100·000	..	100·000

Analysis of long red French-grown beet-root by Professor Baudement:—

Water	83·00
Insoluble matters	3·40
Ashes	0·96
Nitrogenous matters	0·92
Sugar, gum, and mucilage ..	11·72
	100·00

Analysis of long red English-grown mangold, by Professor Voelcker:—

Water	90·500
Soluble albuminous compounds, containing nitrogen 0·42 ..	0·887
Sugar, gum, and mucilage	5·173
Soluble mineral matters	1·083
Insoluble albuminous compounds, containing nitrogen 0·029	0·181
Cellular fibre and pectinous substances (crude fibre)	2·093
Insoluble mineral matters	0·083
	100·000

A glance cast upon the foregoing analyses will at once satisfy the reader that a very material difference exists between English and French-grown roots. The proportion of water in the former is considerably more, and that of sugar considerably less. It is not, then, unreasonable to come to the conclusion that, although much heavier crops are grown in England, yet that the smaller proportion of alcohol-producing substance existing in English-grown roots makes it very problematical whether mangolds could be distilled with advantage in England.

The object of my paper being chiefly to treat of beet-root distillery as it exists in France, it would be quite foreign to my purpose now to examine that important question. I believe the only attempt made in this country by a practical farmer, Mr. Dray, has ended in a failure, and is now abandoned, from what causes I have not thought it discreet to inquire. I merely mention the fact, without presuming to draw any conclusion for or against beet-root distillery in England.

In France it would appear, on the contrary, that the system is highly flourishing, and evidently tends to spread in every district. I give in the appendix a statement of the distilleries existing in France and several other countries. The French distilleries are not confined to the beet-root districts, but are steadily extending into departments where the name of mangolds has hitherto been scarcely known. Thus it would appear that the establishment of these distilleries is an energetic incentive to the cultivation of mangolds, and therefore a happy means of agricultural progress.

In speaking of distilleries I have only referred to the system patented by M. Champonnois, as it is most generally adopted, and is in my opinion the most simple, the most economical, and the most efficient. There are, however, two other systems, which I will only mention by name, that of M. Leplay and that of M. Pluchart: the former consists in distilling the root itself, the latter differs from it in very few points; both are too complicated to be accepted

by the generality of distillers, and are confined to two or three establishments only; whilst the Champonnois system exists in nearly 200 distilleries, operating daily upon two millions and a half tons of mangolds.

I will conclude this paper by giving an analysis of pulp after maceration, according to the Champonnois system, and made by Professor Baudement:—

Water		89·925
Insoluble ashes	1·125	2·030
Soluble „	0·905	
Fatty matters		0·515
Nitrogenous or flesh-producing substances		1·98595
Cellular fibre, &c., insoluble		5·23
Sugar, gum, and mucilage		0·31405
		100·

By comparing this analysis with that of the root itself, it will be seen that the proportion of water has increased 3 per cent., the sugar, gum, and other amilaceous substances have almost entirely disappeared, and the insoluble cellular fibre and pectinous matters have increased five times, whereas the other constituents remain pretty much the same. This would tend to prove that the distilling process introduces little other modification into the composition of the root than the abstraction of the sugar, which is not an important element of nutrition,* and that, weight for weight, the pulp is pretty nearly as nutritive as the roots themselves.

Assuming this to be correct, the production of the spirits would then stand as a compensation for the waste of 24 per cent. which the roots have sustained by the process. It is thus obvious that the selling price of the spirits must in a great measure, if not wholly, determine the expediency of distilling roots upon the farm. I understand it is now selling in England at 10*d.* a-gallon, at which price I apprehend it cannot pay, for the loss of weight in the roots and the expense of distillation must considerably exceed that amount.

With grain at a low price, beet-root distillation is scarcely possible in this country; and where the farmer is so much exposed to the vicissitudes of the corn market, which directly influence the price of raw spirits, it must be admitted that the success of distilleries must be extremely doubtful, the risks of failure more than counterbalancing the chances of gain.

* This is at variance with the opinion of many of our English authorities, and at all events must be considered an unsettled question.—H. S. Thompson.

APPENDIX.

APPENDIX.

No. I.—*Balance-sheet of two Beet-root Distilleries belonging to M. Cail of Paris.*

Farm of La Briche.

Expenses from 1st to 15th February, 1859.

	£.	s.	d.
197 tons 4 cwts. of root at 12*s.* 9*d.*	126	4	0
13½ cwt. of sulphuric acid*	6	16	0
135 lbs. of yeast	2	3	9
70 lbs. of grease	0	3	7
120 lbs. of salt	0	5	5
80 lbs. of purified oil	1	13	8
35 lbs. of ox-foot oil	1	2	11
Wood fuel	6	6	5
Hand labour	8	8	7
12 empty casks	14	8	0
Miscellaneous expenses, carriage of goods, &c.	0	8	4
Victuals to the stoker	0	15	0
Total of expenditure	168	15	8

Produce.

	£.	s.	d.
157 tons 7½ cwt. of pulp, at 6*s.* 6*d.* a ton	50	9	9
1798 gallons of spirit at 90°, at 1*s.* 4*d.*, equal to about	117	5	11
	168	15	8

From the above it would appear that the gallon of spirit costs about 1*s.* 4*d.* to produce, so that whenever the price is under that figure there must be a loss. The tabular statement of the prices of spirit in France for the last 56 years, given below, will show what has been the pecuniary advantage of distilling beet-roots in that country.

Farm of Les Plants.

Expenditure from 4th to 23rd January, 1859.

	£.	s.	d.
102 tons 32 cwt. of roots, at 12*s.*	61	11	10
2 cubic yards of wood fuel, at 4*s.*	0	8	0
9 tons 6 cwt. coals, at 36*s.* per ton	16	14	11
42 lbs. soap	0	12	2
325 lbs. sulphuric acid	1	16	11
50 lbs. of yeast	0	11	2
25 lbs. oil	0	9	5
Cellarage of 1188 gallons of spirits	10	16	0
Hand labour, &c. &c.	7	5	0
Total of expenditure	100	5	5

* Used in the maceration tub to act upon the cellular fibre and facilitate the abstraction of the saccharine matter.

Produce.

	£.	s.	d.
82 tons 170 lbs. of pulp, at 6s. 5d.	26	5	4
1258 gallons of spirits at 90°, equal to	74	0	1
	100	5	5

This would bring the cost of producing a gallon of spirit to only 1*s.* 3*d.* I would observe, however, that in the above accounts no interest is charged for the plant nor any allowance for wear and tear.

No. II.—*Experiments made by Mr. Bella at the Agricultural College of Grignon, taken from Professor Baudement's Report to the Imperial Agricultural Society.*

The object of these experiments was to compare the nutritive value of pulp and raw beet-roots respectively. The programme was as follows:—

1. To take two cows having calved at the same time, and giving the same quantity of milk.
2. To note down the weight of each cow.
3. To note down the quantity of milk given by both.
4. To ascertain, by repeated analyses, the quality of the milk.
5. To give each of the two cows the same ration in weight: pulp to one, roots to the other.
6. To divide the mangers, so as to prevent any error in the consumption of food.
7. To take these diverse measures before the experiment, and ascertain now and then, by weighing and analyses, the changes which may have occurred.
8. In order to secure certainty in the results, to change the régime at the end of a certain time; that is, to give the rations of pulp to the cow which previously was fed upon roots, and the roots to the one which was fed upon pulp.
9. During the experiments to watch carefully the health of the animals, the state of the hair, the skin, the excrements; in a word, everything which may indicate that the animal is in a satisfactory state of health, or else that it cannot bear any longer the régime to which it is submitted.

Two cows, respectively called *Zerbette* and *Aylette*, were selected, and fulfilled all the conditions stipulated above.

From the 29th February, 1856, *Zerbette* was fed as follows:—

	lbs.	ozs.		lbs.	ozs.
Hay	11	4	equivalent in hay	11	4
Raw beet-root ..	56	0	,,	14	0
Chaff and husks ..	6	12	,,	4	0
Straw	11	4	,,	4	12
				32	0

Aylette received at the same time—

	lbs.	ozs.		lbs.	ozs.
Hay	11	4	equivalent in hay	11	4
Pulp	56	0	"	14	0
Chaff and husks ..	6	12	"	4	0
Straw	11	4	"	2	12
				32	0

It is provisionally assumed here that pulp and roots are equal in nutritive qualities.

Under the influence of the two modes of feeding, the two cows produced the following quantities of milk:—

	Feb. 28, before Experiment.	Feb. 29.	Mar. 1.	2.	3.	4.	5.	6.	7.
	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.
Zerbette ..	7·4	7·4	7·3	7·4	7·4	7·4	7·2	6·5	7
Aylette ..	7·2	7·1	7·3	7·8	8	8	7·8	7	7·4

	Mar. 8.	9.	10.	11.	12.	13.	14.	Total.	Average
	litres.	litres.	litres.	litres.	litres.	litres.	litres.		
Zerbette ..	7	7·5	7·6	6·2	6·3	7·2	7·1	106·60	7·06
Aylette ..	7·4	8·2	9	7·4	7·3	7·8	7·8	115·40	7·66

It appears from the above tabular statement, that the pulp régime increased by one-tenth the production of milk, comparatively with the root mode of feeding,—viz. 8·80 litres.

On the 29th of March, that is, after an interval of 15 days allowed to elapse between the two experiments, the order of feeding was changed; *Zerbette* was fed with pulp, and *Aylette* with roots. This new experiment lasted twenty-one days.

	Mar. 29.	30.	31.	April 1.	2.	3.	4.	5.	6.	7.	8.	9.
	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.
Zerbette ..	7·7	7·8	7·9	7·9	7·8	6·5	7·5	9·1	9·3	6·8	7·7	7·2
Aylette ..	8·1	8	8	8	7·9	6·9	6·9	8·2	8·1	6·7	6·6	6·7

	Apr. 10.	11.	12.	13.	14.	15.	16.	17.	18.	Total.
	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	litres.	
Zerbette ..	7·1	7·1	7·4	7·4	6·7	7	6	7·2	7·1	156·2
Aylette ..	6·3	6·3	6·9	6·9	6·7	6·3	5·4	6·5	7·2	148·6

Zerbette, fed with pulp, produced then in 21 days 156·2 litres; average 7·4.

Aylette, fed with roots, produced only 148·6 litres; average 7 litres.

Thus during these two periods of 15 and 21 days the pulp mode of feeding produced respectively 115·40 litres and 156·20: total 271·60.

The root system produced during the same time respectively 106·60 and 140·60 = 255·20. There is thus a quantity of milk equal to 16·40 litres in favour of the pulp.

Analysis of the Milk.

	To obtain one Kilogramme of Butter.	of Caseine.
	litres.	litres.
It required of milk from *Zerbette* before experiment	28·26	32·12
On the 14th March fed with roots	29·	38·10
„ 3rd April fed with pulp	27·5	40·
„ 11th April „	25·5	38·
„ 19th April „	28·5	38·80
It required of milk from *Aylette* before experiment	29·9	46·24
On the 14th March fed with pulp	27·	36·
„ 3rd April commenced feeding with roots	27·	41·
„ 11th April „	31·8	57·7
„ 19th April „	32·1	49·9

The above figures show in what proportions the quality of the milk improved under the influence of pulp feeding, or decreased with roots.

Weight of the two Cows before and after each Experiment.

	Zerbette.		Aylette.	
	Root feeding, 1st Expmt.	Pulp feeding, 2nd Expmt.	Pulp feeding, 1st Expmt.	Root feeding, 2nd Expmt.
	Kilogrammes.	Kilogrammes.	Kilogrammes.	Kilogrammes.
Before	510	517	465	477
After	517	555	477	494
Gain live weight ..	7	38	12	17

There results from this table that the increase in weight of the two cows fed with pulp is double that obtained by the roots.

State of Health of the two Cows.

	Before the Experiment.	Roots.	Pulp.
Zerbette	Good	Bad condition	Greatly improved.
Aylette	Good	Bad condition	Good.

From these divers tables it appears,—

1. That there is a greater increase of produce with pulp than with roots.
2. That the quality of the milk has also improved by the pulp mode of feeding.
3. That the live-weight has also increased.
4. That the condition is more satisfactory.

No. III.—*Extract from Professor Baudement's Report respecting Experimental Feeding of Sheep with Pulp. Visit to Messrs. Wartelle and Deloupré's Farms.*

Your Committee would consider they had but imperfectly fulfilled their task had they not visited some of the farms which supply the Lieusaint Distillery with roots. In those belonging to Messrs. Wartelle and Deloupré we have gathered most interesting information.

The former of these two intelligent agriculturists had made, during the winter season, a comparative experiment upon the feeding of two lots of sheep, each of ten animals; the one fed upon dry fodder according to the custom of the country, the other upon pulp.

The final result of this experiment, which lasted forty days, is as follows:—

For an expenditure of 1*l.* 13*s.* 9*d.* in feeding one lot upon pulp, and of 1*l.* 14*s.* 7*d.* in feeding the other lot with dry fodder, the following difference in the returns was ascertained.

The first lot fed upon pulp produced more than the other:—

45 lbs. meat (net).
6 lbs. 5 oz. tallow.
1030 lbs. manure.

The return in mutton was 39·457 per cent. of the live-weight for the lot of sheep fed with pulp; it was only 38·073 per cent. for those fed with dry fodder.

Mr. Wartelle concludes with us, from these results, that his pulp, which he had reckoned at 7*s.* 4*d.* a ton, in his expenditure of 1*l.* 13*s.* 9*d.*, has a far superior value.

Mr. Deloupré sends every day to the Lieusaint Distillery a waggon-load of mangolds, together with three sacks or three sacks and a half of chaff, to be mixed up with the pulp from a ton of roots. Each sack weighs about 17 lbs.: this gives them a proportion of about 60 lbs. of chaff to 15 cwt. of pulp.

The same waggon brings back to the farm the pulp of the previous day's distilling, ready mixed up with chaff and fermented. Sometimes on its arrival at the farm a further quantity of chaff is added, in the proportion of 56 lbs. per hundred sheep.

The rations are from 7 to 9 lbs. a-head for store sheep, and 22½ lbs. for fattening stock. A trial of 27 lbs. for ewes with suckling lambs succeeded well.

We have never seen sheep-manure richer nor more abundant.

Mr. Deloupré, before his contract with the owner of the Lieusaint Distillery, obtained his pulp from a neighbouring distillery, where the roots are soaked in water instead of the *vinasse* as used in Mr. Champonnois' process. He told us there was a great difference between the two, and we have been enabled to test the accuracy of his remarks.

The pulp produced by the water-process, on being mixed with chaff, does not enter into fermentation; the sheep refuse to eat it, and the only means the farmer could think of to induce his flock to consume the quantity which his contract still compelled him to take from the water-system distillery, was to mix it up with that which he received

from the Lieusaint Distillery; and yet it happened sometimes that the sheep actually picked the latter from the mixture, and left the other untouched. It seems as if it were with these roots soaked in water as with meat kept for a long time in cold water: the sugar and aromatic constituents have been dissolved, and can no longer excite the appetite of animals, or exercise their indirect but incontestable influence in the phenomena of nutrition.

No. IV.—*Market Price of Wine Alcohol in Paris, from* 1803 *to* 1854.

	Average per Hectolitre of 22 gallons. £.	s.	d.
From 1803 to 1812	4	18	1
„ 1813 to 1822	6	13	0
„ 1823 to 1832	3	7	6
„ 1833 to 1842	3	2	0
„ 1843 to 1852	3	3	0
In 1853 and 1854	7	2	0
Average price for 52 years from 1803 to 1854 ..	4	6	9

In the year 1855 beet-root alcohol began to appear in the market. Its average price during the year 1856 was 4*l.* 18*s.* per hectolitre.

No. V.—*Comparative Price of Wine and Beet-root Alcohol in Paris, from July*, 1856, *to June*, 1859, *per Hectolitre of* 22 *gallons.*

	Wine. £.	s.	d.	Beet-root. £.	s.	d.
1856.						
July	7	16	0	6	0	0
August	8	0	0	5	16	0
September	8	4	0	5	4	0
October	8	0	0	5	9	0
November	9	0	0	5	12	0
December	9	0	0	5	8	0
1857.						
January	8	10	0	5	2	0
February	8	4	0	4	16	9
March	8	12	0	4	17	6
April	8	16	0	4	18	0
May	9	0	0	4	17	6
June	9	0	0	4	8	6
July	9	0	0	4	10	6
August	9	0	0	4	5	0
September	9	0	0	4	5	6
October	7	0	0	4	6	0
November		..		3	8	0
December		..		3	0	0
1858.						
January		..		2	8	0
March		..		2	8	0
April	2	14	6	2	2	6
May		..		1	18	6
June	3	5	0	2	4	6
July	3	4	0	2	4	6
August	3	1	8	2	4	0
September	2	12	8	2	1	6
October	2	10	6	2	0	0
November	2	16	0	2	10	0
December	2	16	0	2	10	0
1859.						
January	2	17	0	2	15	0
February	3	3	6	2	14	6
March	3	3	6	2	15	0
April	3	6	0	2	14	0
May	4	10	0	3	16	0
June	4	18	0	4	0	0

No. VI.—*Number of Distilleries on Champonnois' system in operation December*, 1857.

	Number of Distilleries.	Quantities operated upon per day. Tons.	Cwts.
France	186	2297	..
Belgium	15	101	10
Spain	2	19	10
Switzerland	1	4	10
Total	204	2418 tons of roots.	

The distribution of the 186 French distilleries is such as to prove that the cultivation of root-crops is rapidly extending all over France, and is no longer confined to the northern districts. Distilleries now exist in 46 departments, 20 of which belong to the central and southern regions.

Of the above-mentioned 204 distilleries—

54	were established in	1854
48	,,	1855
28	,,	1856
74	,,	1857
204		

In 1858, owing to the extremely low price of alcohol, there were only 2 distilleries established; but this year there are about 20 more in course of construction.

Norwood, June, 1859.

For the following particulars of an English experience on this subject we are indebted to Mr. Henry Hibberd, of Braydon House, Minety, Wiltshire. It will be seen that though they do not correspond entirely with the results of beet-root distillation in France, yet that they are much more encouraging than the analyses given above would have led us to expect. The main facts are, that during the winter of 1857-8, 7000 gallons of proof spirit were distilled from rather more than 700 tons of mangold-wurzel, averaging, therefore, nearly ten gallons per ton, and that during some weeks the produce exceeded thirteen gallons per ton; that the slices, after fermentation and distillation, amounted to 60 per cent. of the original roots, and were saleable at 10*s.* per ton for feeding purposes; that the spirit was not worth more than one shilling per gallon, owing to the impossibility of separating from it an acrid essential oil which made it unfit for drinking purposes; and that, owing to this difficulty, and the impossibility of reaching the market price of good neutral spirit, then worth 1*s.* 10*d.* to 2*s.* per gallon, the experiment entailed a loss.

The method adopted was that of Leplay, in which the fermentation is carried on in the sliced root, and the spirit is separated by super-heated steam passed through the mass in closed vessels. The "cossets" of residual material, removed from these vessels after the process of distillation is completed, are thrown together in a heap, and remain unaltered and fit for food after the lapse of months. In this respect Leplay's method is believed to be superior to that of Champonnois; the residual matter, after his process, being extremely liable to further fermentation ending in putrefaction, and therefore needing to be immediately consumed.

Mr. Hibberd states that, during the winter of 1857-8, he fed 29 milch-cows on hay and pulp from the distillery, and that the whole did uncommonly well. On one or two occasions he ordered some of the cows to be fed on hay only, and they at once showed a considerable falling off from their ordinary yield of milk; so much so that the cowmen, who were at first much prejudiced against the use of pulp, ultimately declared their preference of it to roots of any kind. The cows not only milked well, but kept their condition better than usual; and the pulp was cheap at the 10*s.* per ton charged for it.

It is the ordinary experience of cattle-feeders, and of Mr. Hibberd among others, that mangold-wurzels are unsuitable as food till late in winter, owing to the laxative effect which they produce upon animals fed on them early in the season. This effect was not produced by the pulp remaining after distillation, at whatever season it was given; the cows, while feeding on it, continuing all the time in excellent health. It would seem, therefore, that the root, in losing its sugar, had not lost its value as food for cattle.

Mr. Hibberd's experience was derived from the distillation of large roots, the crops having exceeded 25 tons per acre; so that, in fact, he does not estimate the cost of growing them at more than 7*s.* per ton. It is from these large roots that he declares his produce to have been 10 gallons of spirit and 12 cwts. of food, of equal quality to the original root, per ton. His failure was due to the unsaleable quality of the spirit, not to any deficiency in quantity or strength. When, as he confidently anticipates, some method shall have been discovered of separating the mischievous essential oil, to which the inferior quality of the spirit is owing, there will be no hindrance, in his opinion, to the profitable prosecution of beet-root distillation in England. In order, however, to the success of any new enterprise of this kind, liberty of experiment at every step of the process must be allowed. At present the beet-root distiller is tied down by the Excise rules, which may be well adapted for distillation from malt, but which are not necessarily fit for so different a process as distillation from fermented beet-root pulp.

It may be stated, as a reason for caution in this matter, that no instance is known in which this manufacture has proved profitable in the long run on English ground; but it may also be stated, as an encouragement to the further prosecution of the enterprise, that the reasons given by Mr. Hibberd for this failure seem quite sufficient to account for it, and yet are of such a nature as to hold out a strong probability of their removal.

The yield of 10 gallons per ton of roots has been, in Mr. Hibberd's case, obtained over a sufficient quantity of the crop, and from a crop of a sufficiently-bulky character, to justify con-

siderable confidence in it as a probable future average result. When experiment shall have discovered some method of purifying the produce, so that it shall fetch the ordinary market-price of neutral spirit, there will, apparently, be a sufficient return from the manufacture to make it profitable; and English agriculture will certainly derive a great advantage from any plan by which the whisky and the gin at present obtained from barley shall thus be derived from a fallow crop.

VI.—*The Allotment System.*—By John C. Morton.

Everybody now admits that the so-called allotment system is beneficial both to the labourer and his employer. If the possession of a store of field and garden produce be, as is alleged, a temptation to dishonesty, by the facilities which it affords for secreting the property of an employer, it is even more powerfully and in a variety of ways a security for good behaviour. The allotment of land which provides this store attaches a man to the locality in which he lives—it gives him employment for those hours both of his children and himself which would otherwise be wasted—it adds to the comforts of his home—and it is generally a subject of common interest to himself, his neighbour, and his superiors. All these things tend to make him both contented and respectable. And if, as has been also said, the cultivation of an allotment does prove a tax upon the powers of the labouring man, incapacitating him in some degree by its need of extra work for those ten hours' labour which are due to his employer, it must be remembered, on the other hand, that, by every addition to the comforts and the means of home which it confers, his strength for those ten hours' labour is increased.

But there is ample proof of the influence which has been actually exerted by the allotment system in many a district throughout the country; and we need no longer speak of its probabilities or tendencies as if it were still an untried thing. The object of this paper is to describe its operation in two or three instances, so as to induce its extension to other places where its effects upon the character and condition of the labouring population may be still unknown. The first of these instances—that with whose history I am best acquainted—occurs on the estates of the Earl of Ducie, in the parishes of Thornbury, Cromhall, Tortworth, Charfield, and Wickwar, in the county of Gloucester. The system here is not necessarily called for by excessive population; there is no special difficulty felt either by employers in providing labour, or by workmen in obtaining a livelihood: it was carried into operation as an addition to the comforts of an already tolerably satisfactory condition of the

agricultural labourer. To him, however, it was a most acceptable boon; while, from personal acquaintance with the men and their families in the neighbourhood of Whitfield, on the Thornbury portion of Lord Ducie's property, I am able to say that the improved circumstances and character of the labourer have been an advantage also to his employer.

The Whitfield allotments were first let many years ago, and, after twelve or fourteen years' cultivation, they are as fertile and productive as ever. Lying near the hamlet where most of the tenants live, the land is cultivated by them with the least possible waste of labour in passing to and fro, and with the greatest facilities both for the conveyance of manure to the land and the removal of produce from it. Most of the plots are 60 or 70 perches in extent, varying, however, from less than a quarter of an acre to rather more than half an acre. The way in which the land was let, and the whole scheme organised, may be very shortly described. On application to the late Earl of Ducie, an old pasture close to the village, about 11 acres in extent, was set apart for the purpose. Twenty or thirty cottages stand around or near the field, and to each a plot of ground was allotted. The field was, in the first place, divided into pieces varying in size between the extremes already named, according to the number of the cottagers and their ability to manage it. Paths were made between certain clusters of these plots, and a cart-way was left at either end of the land, for the removal of the produce. Such portions of the field as needed it were effectually under-drained. One-half of each plot was then dug up a good spit deep with the grafting-tool. All this was done during the winter. Sheep were turned in during the following summer. The grass of the halves left undug was thus eaten bare, and the halves of the several plots that had been dug were thus well trodden down. The allotments were apportioned at Michaelmas by lot, each cottager being told in what class, as to size, he was permitted to draw. To those of less ability than the others, whether owing to greater distance from the field, to having fewer children able to assist, or to want of strength or skill, the smaller plots were offered. To those of greater ability, whether of greater need or not, the larger plots were offered. It was urged that to allow these plots as a mere makeshift in aid of the necessitous, would have a pauperising tendency. It was an opportunity to them, offered according to their ability, not according to their need; and it thus acted as a premium upon every good quality they possessed or could acquire.

The previous management of the land placed it in the hands of these allotment tenants in first-rate order: the half which had been dug six months or more before, and trodden down all the summer by the sheep, was in the best possible con-

dition for receiving wheat; and the other half in grass was ready to be at once dug up for potatoes, beans, or other vegetables, during the ensuing spring. The new rent demanded was determined by charging, in addition to the former agricultural rent, five per cent upon all that had been expended by the landlord in carrying out the scheme. The drainage of the land, the plotting and digging it, the loss of rent of the land half dug,—all these added together, constituted a principal sum, on which five per cent. was charged in addition to the former rent. To this was added the estimated rates and taxes, and the cost of keeping fences in repair, together with 1*s.* from each of the allotments (about 3*s.* an acre on an average); this last to constitute a prize fund in furtherance of good cultivation. The whole rent thus ascertained was allotted over the several plots in proportion to their size and the quality of the soil.

The only conditions imposed upon the tenant, beyond the regular payment of his half-yearly rent, were that he should cultivate the land by manual labour, that he should not crop more than half his land with wheat or potatoes, and should give up the whole at the end of a year if required to do so.

There can be no doubt that this eleven acre field has been a great addition to the comforts of the village of Whitfield; and any one who sees the whole village population, young and old, at work upon it during those evening and even moonlit hours of spring and autumn, which would otherwise by many of them have been worse than wasted in the beer-house, must feel that the good influence of these field-gardens extends, beyond the mere material condition, to the character as well. The latter consideration is less capable of definite estimate or proof—it is incapable of reference with certainty to its causes; but, in valuation of the former, I know that many a half-acre in the Whitfield allotment-field, which formerly contributed perhaps one-sixth to the annual keep of a cow, now provides one-fourth the bread-corn needed by a family, with more than that proportion of the potatoes they consume. Thirteen or fourteen bushels of wheat, and more than two tons of potatoes, are thus obtained from many a half-acre of land. "I would rather have my plot and pay a heavy rent for it, than have a 5*l.* note for nothing once a year," is the common testimony. The rent does not exceed 3*l.* an acre, and the land was probably worth 50*s.* as a pasture-field. It is punctually paid, and there never was a defaulter during my connection with it.

The Michaelmas rent-day was signalised by the award of prizes, namely, 1*l.* to the best cultivated allotment, and a return of the half-year's rent to the second best; and for this funds were provided by the allottees themselves, in the additional rent taken from them for this purpose. As they thus provided the

prizes which they received, it was fair that they should themselves award them; and, accordingly, this was annually done by their own vote, and always done, so far as I could judge, with perfect justice.

There have been one or two cases in which, without this competition, and superintendence by men in the class immediately above them, labourers have lost interest in the cultivation of their allotments, and the system has been abandoned. There have probably been other causes in operation in such cases to produce this result, but there can be no doubt that, whether necessary or not, an interest taken by the landowner and tenant-farmers of the district in the success of the allotment-field tends greatly to ensure success; and if shown in such a manner as, by the offer of prizes, to encourage wholesome rivalry among the allottees, it will be still more beneficial.

Since I left the neighbourhood of Whitfield, seven years ago, the allotment system has been greatly extended in the neighbouring parishes, and the present Earl of Ducie has now, I believe, several hundred tenants of this class. The competition, which is so important an element in the successful management of the system, is now carried out on a greatly extended scale, and no day in the year is anticipated with greater interest in that neighbourhood than that on which the annual exhibition of allotment produce is held in Tortworth Park, when the gentry of the neighbourhood, as well as many from a distance, assemble as Lord Ducie's guests, to meet all of every class who can give themselves a holiday, and witness the award of premiums, both for good cultivation, and for those interesting proofs of it which are exhibited on long tables under tents and trees within his Lordship's park. Lord Ducie has been kind enough to send me a statement of his experience on the subject of these allotment exhibitions, and his judgment of their influence on the character of allotment cultivation on his estate, from which the following is an extract :—

"These Exhibitions of Vegetables and Fruit were first commenced in September, 1854; they are confined to my own tenants, whom I divide into two classes, viz., farmers and allotment tenants. Of the first class, as your object is to treat of allotments only, I need not write, and shall confine myself to the allotment tenants, whom I find it convenient to define as those persons holding not more than one acre of land. The majority of them hold about one-third of an acre, though a good many hold even less than this.

The following are some of the statistics of the Exhibitions :—

	1854.	1855.	1856.	1857.	1858.
Number of Articles Exhibited	750	987	1126	1242	1015
Number of Exhibitors	266	295	311	266	223
Number of Prizes given	72	73	76	88	81

It will be observed that there is a diminution in the number of Exhibitors in 1857, while the number of articles is on the increase. This I conceive to be caused by the reluctance of those who have never been successful, to continue what may appear to them to be a hopeless contest; while the increase in the number of articles, in spite of the falling off of the exhibitors, is, I believe, owing to the converse eagerness of those who have been already successful to compete in a greater variety of articles.

If my inference be correct, a question of some difficulty arises, whether the same persons should be permitted, year by year, to take the same prizes, and, by their established reputation, discourage others from competition; while, on the other hand, their skill and success undoubtedly merit a reward. The apparent tendency of the Exhibition at present is to narrow the competition to a limited number, whose example, nevertheless, cannot but prove salutary to their fellow allotment holders.

With regard to the general stimulus given to allotment cultivation by these Exhibitions, I find that, although there is no great improvement in allotment fields which were originally well cultivated, there is a tendency in all to arrive at a certain level of good cultivation: while the Tortworth, Whitfield, Wickwar, and Cromhall districts appear to obtain about the same proportion of prizes as at first, the Charfield district, which, in 1854, was pronounced to be inferior in cultivation to the other districts, and which only gained one prize to every thirteen articles exhibited, gained last year one in five and a half, having gradually progressed up to this point, which is but slightly below the average of the other districts.*

I am led to observe that some vegetables require a peculiar skill in their cultivation, and that this skill is confined to a comparatively small number of persons. In onions especially—in which the number of competitors varies between fifty and ninety—eminent success appears to be confined to the most limited number, for the same person has taken the first prize in four out of the five Exhibitions. I may here remark that he has for forty years produced and used his own seed.

Carrots appear to show a similar result in a lesser degree; in parsnips and turnips it is shown slightly.

In potatoes a greater uncertainty prevails. In only one instance has the same exhibitor taken a first prize on two occasions. At the same time there is a group of names which appear often in some part of the prize list for this vegetable.

The exhibitors who obtain prizes for fruit are frequently the same individuals—the possession of a good tree tending to ensure success, without much exertion on the part of its proprietor.

This branch of the Exhibition, though not directly advantageous to cultivation, I consider to be most useful, as it enables us to compare the fruits of the various districts, and encourages us to propagate those varieties which, by their long-continued success, seem best adapted to the soil and climate.

I am unable to extract anything further of more than mere local interest from the tables; but, passing from facts to sentiment, I venture to record my conviction that such Exhibitions—as affording an opportunity for an useful and rational holiday, as bringing a landlord into friendly and graceful contact with his tenants, and as stimulating those tenants to exertions beneficial to both—are institutions which cannot be too highly estimated or too generally adopted."

Every successful superintendent of allotments makes annual

* This statement might appear irreconcileable with the figures already given, viz., 81 prizes to 1015 articles. A great many deductions however, on account of extra and non-competing produce, and other items which it would be impossible to explain briefly, will bring the average to about the amount stated.

rivalry of this kind—whether by the award of inspectors for the best cultivated plots or by prizes for specimens of produce annually exhibited—an essential part of his management. Mr. Richard Westbrook Baker, of Cottesmore, near Oakham, has for many years paid much attention to the letting of small pieces of ground, not exceeding a rood, to agricultural labourers to cultivate as they pleased. The imperfections, however, in such lettings induced him, so long ago as the year 1830, to establish an allotment system; to this he has adhered with great success, and now can show more than 200 of the best cultivated allotments in England. He too has for more than a quarter of a century had an annual examination, and prizes are awarded in various parishes in Rutland in the last week in July or the first week in August. He appoints three gentlemen as Judges to make the awards, taking them round the country himself.

The Rev. Professor Henslow has probably had more experience than any other person, of the effect of competition and of the annual exhibition of produce on the character of allotment cultivation and the consequent success of the allotment system. It is hardly compatible with my present limits that I should attempt even a mere *resumé* of the large mass of papers with which he has been good enough to favour me on the successive annual horticultural and allotment shows and village gatherings of Hitcham for many past years. A feature of comparatively recent occurrence in these shows must, however, be specified. The competition, till lately confined to the cultivators of the immediate locality, has latterly been extended, and the annual report now declares the judgment of Messrs. Steel and Ramsay, of Battersea, on the onions and potatoes sent to them by allotment tenantry from the parishes or hamlets of Hitcham (Essex), Bramborough Pool (Cheshire), and Whitfield (Gloucestershire) respectively! Rivalry, anyhow and with any one, is, no doubt, a great incentive to effort; and these competing allottees, though in these cases so widely separated, doubtless benefit themselves and one another in their efforts to excel. The results, too, of a competition of this kind give a wider interest to the reports which annually emanate from Hitcham, so that distant parishes are brought under the influence of Professor Henslow's admirable example in every kind of effort for the well-being of a country population. Meagre as is this reference to the allotment system of Hitcham and the neighbouring parishes, it will, I hope, suffice to whet the curiosity of inquirers into this subject, and induce a more particular examination of the successful management adopted there.

The remainder of this short paper must be devoted to an account of the system as carried out on an enormous scale and under a less detailed superintendence on the estates of Earl De Grey in Bedfordshire.

The allotments now referred to lie in Silsoe and the neighbouring parishes near Ampthill, in that county. They are 618 in number and held by 584 tenants. They are 294 acres in extent, averaging as nearly as possible half an acre to every allottee. The soil is of various character and quality, between the extremes of very light sand and stiff calcareous clay. Lying as the district does geologically below the chalk, where a series of alternating clay and sand beds occur, this extreme variety of soil is easily accounted for. With the exception of one or two fields in the parish of Clophill, where the soil is very light, and some portions of an extremely stiff character in the parishes of Gravenhurst, the land is well adapted for garden culture. Much of it is remarkably productive, owing this character to its fortunate geological position as well as to good cultivation. Nothing could look better than the loamy and light soils of Silsoe and Flitton last May under allotment culture. The rents vary from 8*s.* to 18*s.* a rood; the poor's and other rates, and the cost of keeping roads and hedges in repair, being borne by the landlord. Of a rental exceeding 1500*l.* in allotment gardens and cottages there was an arrear of only 1*l.* 15*s.* 6*d.* last year, and that was in the case of a widow who, during that season, had lost her husband by sudden death, and to whom the rent would be forgiven. This fact is of itself sufficient to prove the value of these gardens to the labourer and the safety of the system to the landowner. That there is a special fitness belonging to it in the neighbourhood of Silsoe, making it there more than usually advantageous to the tenant farmer, may also be admitted; but everywhere the tenantry are interested directly and materially in such a condition of the labourer as shall both diminish poor's rates, and, by increasing their means, give both labourers and children a certain facility for the prevalence ultimately of a better education among them.

The labouring population in the neighbourhood of Silsoe is unusually dense for a purely agricultural district. The wages are 9*s.* or 10*s.* a week, paid generally by the piece, even to men whose services are engaged by the year. This piecework payment has not proved inconsistent with that friendly and long-continued relationship between master and men, founded on mutual good-will, which is the best guarantee of the worth and respectability of both classes in so many English country districts. There are as many instances of this kind in this district of piecework payment and allotments, both of which are supposed to create undue independence, as there are elsewhere. The fact is that, here as everywhere, an interest in the welfare of the labouring man, shown by endeavours to put him in the way of self-improvement, produces its natural fruit in that goodwill on which social welfare depends.

Mr. Trethewy, the agent over the Earl de Grey's estate, read a paper last November before the Central Farmer's Club, on the uses and abuses of the allotment system, and adduced the history of Lord de Grey's allotments as his principal illustration. He declared it as his opinion, the result of a large experience, that the subject involved the comfort and prosperity of the occupier quite as much as of the owner of the land or of the labourer. "Any system having a tendency to elevate the moral character of the labourer and improve his condition must be worthy of encouragement by the farmer." Mr. Trethewy alluded to the special fitness of this system where labourers live in villages and where sufficient garden-ground cannot be obtained adjoining to the cottages. In choosing a field near the village, for the purpose of allotments, he says:—"The *nature* more than the *quality* of the soil should be considered, for it is astonishing how much poor thin land is improvable by spade husbandry, while strong and heavy clays are wholly unfit for the purpose of allotments, no matter how well they may be drained."

The following are his very sensible remarks on the importance of confining the allotments to a manageable extent of mere garden ground:—

"My experience convinces me that a rood is sufficient under almost any circumstances; and the greatest error that has been committed has been the allotting of too much land to one individual. To dwell upon the evils arising from such a proceeding is scarcely necessary, as it must be obvious that without sufficient capital the occupation of land cannot be attended with profitable results. Some instances in confirmation of this view have come under my own observation, and I can confidently assert that, instead of the position of such men having improved, it has retrograded. Occupied nearly the whole of their time upon their own land, they can no longer be classed under the head of labourers, and they actually injure regular workmen by throwing their labour into the market at seasons of the year when the demand for it is unusually depressed. If it be argued that the restriction of the system would have the effect of preventing a labourer from improving his condition, and effectually debar him from rising in the world by his own industry, I would answer that I am not now discussing the relative advantages of large and small farms, but am confining myself to the agricultural labourer in the broad acceptation of the term. Every employer knows, and every man of common sense must feel, that it is as important to the farmer to have his regular men at work at all times, as it is to the manufacturer or tradesman, and that the business of the farm could not be carried on without such regularity. I regard it, then, as a fatal error for the labourer to follow any pursuit that would at all interfere with the claim of his employer upon him; for, be it remembered, that it is upon *hired* labour that the working man must chiefly depend for his subsistence; and any scheme that has a tendency to interfere with this his chief capital, must very shortly end in disappointment and distress."

The Silsoe allotments date from the enactment of the new Poor Law, and the early promoters of the scheme were driven to it by the pressure of the poor's rates. The improvement in the condition of the labourer there and elsewhere is, no doubt, partly

the effect of the new Poor Law, which has taught him that his first dependence must be on his own exertions; but a share in that improvement around Silsoe must certainly be allowed to the allotment system as there established. At first the allotment tenantry were allowed a considerable extent of land apiece—two acres or more. As much, indeed, as they declared their ability to manage was allotted to each applicant. But as these have gradually fallen in or failed, they have been subdivided; and from a rood to half an acre is now the ordinary extent allowed. There have been no restrictions placed upon the cultivators of these plots, but such as are also laid upon the farmers of the district. There is no formal provision against Sunday labour or against immorality, nor are there any special legal securities taken for the relapse of the land to the owner in case he should require it. Every security, nevertheless, exists as to all these particulars in the general sense of propriety which prevails, as well as in the knowledge that sufficient power exists in the management to enforce it. On riding round these allotments late in May this year, I saw poppies, turnip-seed, onions, peas, and cabbages, in some cases grown to a large extent; but the ordinary crops were wheat and potatoes for home consumption. In a few instances the land is in the hands of market-gardeners; but, as a general rule, the allotments are occupied by agricultural and other labourers; and the following table, extracted from Mr. Trethewy's paper, gives their extent and their number in the several parishes, together with interesting details regarding parochial rates since the period of their establishment:—

Parish.	Population per census of 1851.	Area of Parishes.	Number of Allotments.	Acreage of Allotment Land.	Annual Average of Five Years' Parochial Rates to Lady Day. 1858.	1848.	Parochial Rates for the Years 1828.	1833.	1835.	1838.
		Acres.		Acres.	s. d. (in the £ upon rateable value.)	s. d.	s. d.	s. d.	s. d.	s. d.
Silsoe	755	2067	78	24	2 10	2 3	7 5	5 6	3 3	2 6
Clophill	1186	2317	180	55	4 4	4 0	7 4	6 9	3 4	4 9
Flitton	656	1020	163	140	5 2	4 10	13 0	9 0	6 0	4 0
Pulloxhill	688	1584	131	51	3 2	3 6	11 0	12 0	6 0	3 8
Upper Gravenhurst	357	895	66	24	4 4	4 3	7 9	5 6	3 2	4 10
Lower Gravenhurst	58	757			2 0	2 1	2 0	2 0	1 0	2 10
			618	294						

I conclude with Mr. Trethewy's statement of the superiority of these clustered field-gardens over detached cottage-gardens, and of the advantages of encouraging rivalry by an annual judgment of cultivation and exhibition of produce:—

"(1) Every man has the advantage of the experience of the whole field, and generally benefits by it; whereas in a garden there are not those opportunities. (2) How frequently does one see a garden overrun with weeds, overgrown with

trees, bushes, and fences, absolutely excluding sun and air, and producing next to nothing to the cultivator! In an open field-allotment the sun and air are freely admitted; the land is more easily kept clean, and the state of cultivation patent to all the neighbourhood. (3) I believe example has a strong influence in promoting good and clean cultivation among all classes of occupiers. With a view to encourage it amongst the allotment tenants of the district, a society, called the 'Silsoe and Ampthill Labourers' Friend Society,' was established about seventeen years ago. It offers several prizes annually for competition, and great interest is excited among the exhibitors. This society is under the patronage of Earl de Grey, and has Lord Wensleydale as president; while the stewards consist entirely of tenant farmers, who thus evince their sense of its usefulness. The subscribers comprise the clergy and gentry of the neighbourhood, and the exhibition is invariably fully attended. In fact, all classes unite to promote the object it has in view; and the result is an exhibition of fruits, vegetables, &c., that would surprise any one who had never before witnessed it. I believe this to be a most useful institution; and, where allotments prevail to any extent, I would strongly recommend the establishment of similar associations."

The almost universal testimony of experience on this subject confirms the conclusion to which, after Mr. Trethewy's paper, the discussion before the Central Farmers' Club led—that the system may always be expected to benefit both labourers and their employers, excepting under extravagant misguidance or neglect; *i.e.*, excepting (1) where the land set apart for the purpose is altogether unsuitable in character, or (2) too distant from the cottages of the allottees, or (3) where an excessive extent is permitted to the tenantry, or (4) an excessive rent demanded from them, or, lastly, (5) where the tenantry are left entirely to themselves, and no effort made to excite their rivalry or pride in good cultivation.

A landowner, proceeding upon the plans adopted so successfully on the estates of the Earl of Ducie and the Earl de Grey, and in the spirit so admirably exemplified at Hitcham, may, I think, confidently expect a great improvement in the condition of the labourers on his estate, and this as the result of an effort attended by no cost to himself.

VII.—*Anbury; and the Analysis of Diseased Turnips.*

By Dr. Augustus Voelcker.

It is well known that turnips grown upon light sandy soils are much more frequently affected by "Anbury," or "fingers and toes," than roots grown on stiffer land, containing a fair proportion of the four chief components of all soils—clay, lime, sand, and vegetable matter.

The cause of these disorders in the turnip-crop is justly referred in most instances to the absence or insufficiency of lime in

light sandy soils; hence the manifest benefit with which lime, chalk, marl, shell-sand, and other calcareous manures are used as preventives of this and similar diseases in turnips on such soils.

But, at the same time, it must not be supposed that the absence or deficiency of lime in land is *always* the cause of fingers and toes in turnips, and that liming is a *universal* preventive of this disease. In proof of this, I may observe that not long ago I examined a soil which contained plenty of lime, and yet produced diseased turnips; and also that I have seen fingers and toes in roots grown on calcareous soils, probably containing from 30 to 40 per cent. of lime. If it be remembered that the ash of turnips contains some ten or twelve different kinds of inorganic matter, it will not appear strange that the absence of available potash, or the insufficiency of phosphoric acid, or the want of sulphuric acid in the soil, may produce diseased turnips as well as the deficiency of lime. There can be no doubt that we should know much more respecting the causes of the increasing failures in turnips than we do at present, if we were less apt to take things for granted, and were more inclined to examine a great number of cases, even at the risk of adding nothing more to our existing stock of information on the subject. Viewed in this light every well-authenticated case of disease in turnips must have some interest to the botanist and the agricultural chemist.

I therefore gladly availed myself of an opportunity of inspecting a crop of turnips affected by Anbury in the most extraordinary degree. A brief account of the case, and the subsequent examination of the soil and evils to which it led, may, I trust, not be altogether void of interest to the agricultural reader.

The instance just referred to occurred on a farm at Ashton-Keynes, a village about six miles from Cirencester. On visiting the farm, Mr. Plumbe, the occupier, directed my attention to a field of considerable extent on the slope of a hill. Surrounded by a tract of country visibly abounding in limestone-gravel, the field on the slope and top of the hill presented a striking contrast, even to a superficial observer, with the fields at the base of the hill. These were moderately stiff, full of limestone-gravel; and the root-crops on them looked healthy, promising a fair average yield. The elevated field in question, on the contrary, was sandy in the extreme; apparently contained but little clay, no limestone-gravel whatever, and the turnips on it were affected by Anbury to such an extent as I never witnessed before. There was hardly a sound turnip to be seen, except on two isolated spots, to which I shall refer presently. With this exception, the whole of the roots were so much injured by the disease that it was not considered worth while to send sheep over the field. The young plants came up well, I was informed, looked

remarkably strong and healthy up to the time of singling—so much so, that a very fine crop was confidently expected. However, soon after, the crop made no progress, and the roots on inspection were found to be all more or less attacked. At the time of my visit they presented a most extraordinary appearance, being forked and twisted into the most fantastical forms, and covered with wart-like excrescences; exhibiting thus the characters of Anbury in its most malignant form.

Part of the field was covered with a brownish-coloured sandy soil, part with a red-coloured ferruginous soil. I examined both on the spot, and prepared a well-mixed sample of each, as well as of the subsoil on which the red-coloured soil rested.

The subsequent chemical analyses of these three soils, dried at 212° Fahrenheit, yielded the following general results:—

	No. 1.	No. 2.	No. 3.
Organic matter and water in combination	5·36	4·82	7·64
Oxides of iron and alumina..	5·78	12·16	22·77
Carbonate of lime	·25	·15	·44
Alkaline salts and magnesia	·41	·46	·69
Phosphoric acid	traces.	traces.	traces.
Sulphuric acid	·08	not determined.	
Insoluble siliceous matter (chiefly sand)	88·12	82·41	68·46
	100·00	100·00	100·00

No. 1 was taken from the top of the hill, where the turnips were most affected by Anbury.

No. 2 was a red-coloured soil from the slope of the hill, where the turnips were likewise much diseased.

No. 3 is a deep red-coloured ferruginous subsoil on which No. 2 rests.

In this subsoil, it will be noticed, there is a great deal of oxide of iron, a constituent which is likewise more abundant in No. 2 than in No. 1.

The amount of lime in all three is very trifling: in the surface soils, especially, it is totally inadequate to meet the requirements of a crop of turnips. We cannot doubt, therefore, that the deficiency of lime in these soils has been the principal cause of the failure of the root-crop on this field.

That lime might have been applied to this field with great success will appear from the following interesting circumstance with which I became acquainted on my visit to this farm. When walking over the field, Mr. Plumbe directed my attention to an isolated spot, not many square yards in extent. On this spot the turnips, though by no means large, were nearly all sound. On stooping down and examining the soil, I picked up some bits of

whitish-looking substance, which appeared to me like dried gas-lime, and I learned afterwards that on this very spot a cart of gas-lime had been unloaded the year before. Mr. Plumbe likewise pointed out to me a spot in the corner of the field: here, likewise, the roots looked quite healthy, scarcely one diseased turnip being seen.

I took samples from both spots with me, and submitted them to analysis.

Dried at 212° Fahrenheit, 100 parts of each yielded the following results:—

	No. 1.	No. 2.
Organic matter and water in combination	4·15	4·24
Oxides of iron and alumina	4·01	4·98
Carbonate of lime	1·77	·93
Alkaline salts and magnesia	1·12	·69
Insoluble siliceous matter (chiefly sand)	88·95	89·16
	100·00	100.00

No. 1 is the soil from the spot on the field where gas-lime was distinctly visible.

No. 2 is the soil from a corner of the field where the turnips were quite sound.

It will be seen that in No. 1 there was a good deal of lime in the shape of gas-lime, and that in No. 2 there was also much more lime than in the rest of the field where the root-crop failed entirely.

The larger amount of lime in the soil taken from the corner of the field is probably due to a dungheap, which in previous years had been set up on this spot. As all the other fields on this farm abound in lime, the manure produced on this farm naturally must contain more lime than is found in farmyard manure made in districts where lime is less abundant in the soil than in localities where oolitic rocks abound.

I may state, in conclusion, that I have analysed one of the most diseased roots, and also separated the body, or more uniform portions of another root, from the finger-and-toe like excrescences.

The whole root, affected very much by Anbury, yielded the following results:—

	In natural state.	Calculated dry, (dried at 212° F.)
Moisture	88·02	..
*Protein compounds (flesh-forming matters)	3·56	29·55
Cellular fibre	3·27	27·29
Sugar, gum, pectin, and indigestible fibre ..	3·67	30·79
Inorganic matters (ash)	1·48	12·37
	100·00	100·00
* Containing nitrogen ..	·57	4·76

The more uniform portion, or the body of the second root, gave:—

	In natural state.	Calculated dry, (dried at 212° F.)
Water	89·50	..
*Protein compounds (flesh-forming matters)	2·34	22·37
Non-nitrogenized substances (heat producing principles)	7·13	67·77
Mineral matters (ash)	1·03	9·86
	100·00	100·00
* Containing nitrogen ..	·37	3·58

The finger-and-toe like excrescences of the same root gave:—

	In natural state.	Calculated dry, (dried at 212° F.)
Water	86·70	..
*Protein compounds (flesh-forming matters)	3·96	29·81
Non-nitrogenized substances (heat-forming principles	8·06	60·56
Mineral matters (ash)	1·28	9·63
	100·00	100·00
* Containing nitrogen ..	·63	4·77

Compared with sound turnips, the diseased roots are much richer in nitrogen and in mineral matters. It will be noticed that the root which was most affected by Anbury contained nearly the same proportion of nitrogen which was found in the finger-and-toe like excrescences of the second root. This is more than double the quantity of nitrogen which is contained in sound roots. I may observe, in passing, that I have been occupied for some years past with the examination of roots, and invariably find that roots which practical men pronounce to be worthless, or very poor, contain much more nitrogen than roots which are highly esteemed for their nutritious and fattening properties. But I must not enlarge on this matter at present. As I shall probably be occupied for several years with researches into the composition of turnips, before they are in a sufficiently advanced state for publication, I thought it desirable to mention in the mean time that *no greater error can be made in practice than to estimate the feeding value of turnips by the amount of nitrogen which different sorts contain.*

Royal Agricultural College, Cirencester,
June, 1859.

VIII.—*On the Cultivation of the Lupine as Food for Sheep.*

To the Council of the Royal Agricultural Society of England.

Gentlemen,—I am induced to place the subjoined communication before you, relative to the cultivation of a leguminous plant (the Lupine) on poor sandy soils.

My attention was first directed to the growth of the lupine by Baron Herm. von Nathusius, of Hundisburgh, Prussia (a large landed proprietor, who has devoted much of his time to agriculture, both in its practical and more scientific departments). In 1856 he was kind enough to give me two bags of seeds—one of the blue, the other of the yellow variety—which I planted upon what is here called poor, blowing, sandy land; and the productiveness of the plants greatly surprised me. In 1858 I drilled about one bushel per acre of seed, upon eighteen acres of poor land; from which I obtained fifty waggonloads of sheaves, similar to those which accompany this paper. The luxuriance of this crop quite astonished all that were acquainted with the sterility of the soil; and the quantity of grain, before harvesting, was estimated by various persons at from forty to fifty bushels per acre. The very lucid account given by the Baron Herm. von Nathusius in the accompanying communication, is a far better testimony to the value of the lupine than any which my short experience enables me to offer; and in addition the Baron, in a letter to me dated December 18th, 1858 (in answer to a request of mine that he would furnish me with his experience respecting the growth of the lupine) says:—"We have had here the most unfortunate season I ever remember; we have lost all our clover-layers by excessive dryness, and the lupines are the only crops which can help our sheep through the winter. It is really a valuable plant for some sorts of soils. I had a field of thirty-six English acres drilled with blue lupine in May, after the young clover-plant was lost; and one of my neighbours offered me fifty-seven bushels per acre for the thirty-six acres—which I refused. In my letter I omitted to state that the yellow lupine is the better for hay, straw, and chaff; but the blue is generally more productive in grain."

My past success, I think, fully justifies me in commending the cultivation of these lupines to the notice of the occupiers of light sandy soils, to whom, I believe, it will hereafter prove of immense advantage.

Believe me, Gentlemen,

Yours very truly,

Butley Abbey, Feb. 1859. Thomas Crisp.

On Lupines.

About ten years ago the cultivation of this plant, which for a long time had been grown for an ornament in flower-gardens, was introduced into regular farming. We cultivate two distinct species—the yellow and the blue lupine (*Lupinus luteus, et Angusti folius, Linn.*). The yellow lupine has yellow flowers; the whole plant is more succulent, with more and larger leaves, and with a softer stem; the seeds are smaller, and of a lighter yellowish colour, with darker speckles. The blue lupine has blue flowers; the plant is stiffer and harsher, the leaves smaller and not so plentiful, the seeds somewhat larger and of a darker colour. Both plants have nearly the same conditions of vegetation. What makes them very important for agriculture is their growing luxuriantly on light, poor, sandy soils, in situations where no other of our leguminous plants could live. We have some districts in the northern parts of Germany and Prussia where a miserable crop of rye was nearly the only production, and where even buck-wheat would fail in dry seasons; and it is in such situations that farming has become profitable by the cultivation of the lupines, and where, in consequence, the rent has been much more than doubled. For such poor dry land it has been proved a good plan to sow the yellow lupine (especially this because it is more succulent) in June; to roll it down when it is in full flower, the first pods beginning to show; to plough the field, and to sow a corn-crop some weeks after ploughing, and very often a better crop has been raised than after manuring with cattle-dung, a stuff of course not abundant in such poor situations. There may be some conditions when such a manner of "green-manuring," as it is called, may be advisable, but generally I think it a much better plan to fold off the plant with sheep, which, not at first, but after they have been accustomed to it, are very fond of the yellow lupine in this state, and thrive remarkably well on it. If the seeds are sown in spring, which we here dare not do before the end of April or the beginning of May, sharp night-frosts being destructive to the young plant, the vegetation is slow in the first weeks, but it soon becomes very rapid. In the poorest soil, if any rain falls, the plants grow to the height of three or four feet, and a great quantity of beautiful flowers cover the whole field. The seeds of the first flowers begin to ripen when the top of the plant is still blooming, and for that reason the plant must be cut before finishing its growth; even then there is always some loss of seeds, the ripe pods being very prone to open by the heat of a sunny day. The best plan to secure good seeds, when labour is cheap enough, is to send children into the field before mowing, or after mowing

between the swathes, to pluck the pods, and then to dry them separately. There is some difficulty in drying the crop after mowing, and the more so if the plant is very succulent and not quite ripe. But after having been sufficiently dried, the blue lupine makes most excellent hay for sheep. The best plan is the Belgian fashion of drying clover: three poles, of 8 or 10 feet high, and some sticks fastened horizontally on the poles, forming a pyramid—which is entirely covered with the plants after they have been exposed some days to the sun and air. The usual way of harvesting beans will answer best, if the pods are mostly ripe, and the crop intended for thrashing.

The seeds of both varieties form very superior food for sheep, lambs, and fattening wethers. After they had been weaned to it, I have often seen them refusing cake if they had plenty of lupines. The straw and chaff is excellent for store sheep. It has been found by many persons that lupine hay, straw, and corn, are in some degree preventives of the rot, and even sometimes remedial, if the danger is just beginning and the disease not far advanced. We know of no other plant which, generally speaking, is so peculiarly adapted for sheep.

The seeds have been used for horses and cattle, and undoubtedly it has been found profitable to mix them with oats or beans, but they generally refuse a greater quantity. Some small farmers now begin to give lupine-meal with milk to the weaning calves, and they are said to do well, and that the grown cattle afterwards are fond of the plant. Swine generally refuse them, and some experiments to extract their peculiar bitterness by water or chemical agents have not led to important results.

The following is the result of an analysis of the air-dried seeds:—

	Per cent.
Water	14–15
Nitrogenous substances	33–36
Fatty matter	6–7
Starch, sugar, &c.	26–30
Woody fibre	11–12
Mineral matter	3–4

We learn from this analysis that the lupine seeds contain a greater percentage of nitrogenous substances than any other of our leguminous plants; so that their high value is fully confirmed by science.

Generally the seeds are sown broadcast, about two imperial bushels to the imperial acre, or even somewhat more. I drill $1\frac{1}{3}$ bushel to the acre (eight metzen to one Prussian morgen), in rows 12 or 18 inches apart, and clean them by horse-hoeing and weeding. They are very apt to make the land foul; and it is really wonderful to see how the poorest land, which

scarcely used to grow a few annual grass-plants, in the shade of the luxuriant lupines is immediately covered with different weeds; even couch-grass making its appearance where it was formerly unknown. For such poor land the lupine has some peculiarly fertilizing influence.

The cultivation of the lupine is so very new, though many thousands of acres are now to be seen, that it is not quite decided on what kind of soil it will be grown with most profit. There is no doubt that it is a real boon for the poorest sandy and gravelly soils, but for soils of a better description it is no less a very profitable plant. Chalk and calcareous sand seem not to be favourable for it, nor wet and undrained land. Some years ago, when first introducing the lupines into my neighbourhood, I drilled some bushels on a piece of rich, highly-cultivated land of my home-farm, which had been heavily-manured for beans. The season being favourable, the beans grew to a height of more than 5 feet; the lupines, on the contrary, in the same field, were only a few inches high, and bore the most miserable appearance, with only some single flowers. In the same year, on another farm, on a loamy sand, unmanured, and after a corn-crop, I had the lupines nearly four feet high; and notwithstanding the field being covered with fallen seeds, they having become too ripe before mowing, I had thirty-eight imperial bushels per acre (sixteen scheffel per morgen).

One of our most ingenious agriculturists—H. von Wulfen—some forty years ago introduced the white lupine (*L. albus*, *Linn.*) from the southern parts of France, and cultivated it during his lifetime on poor sandy soil as "green manure." He was reluctant to give it up, though no cattle would touch it, and notwithstanding that the seeds often failed in our climate, because he anticipated the great importance of that genus of plants for the agriculture of the northern climate. His white lupine is now nearly forgotten, but his anticipation is fully justified.

We now are trying some other lupines. The *Lupinus termis* of Forskal from Egypt, which is cultivated in Sicily, shows a very luxuriant growth, but most probably the seeds will not always ripen with us.

HERM. VON NATHUSIUS.

Hundisburg, Magdeburg, Prussia.

IX.—*American Implements, and Methods of Economizing Labour.* By C. W. EDDY, M.A. Oxford, late Radcliffe Travelling Fellow.

WHEN it is considered that America has been brought by the mighty agency of steam within ten days of our shores, and that it

is visited yearly by thousands of Englishmen for the purposes of business, in the pursuit of pleasure, or the search for a home, it might be reasonably supposed that all points of interest observable on that great continent, and especially among those energetic kinsmen of ours who occupy the northern part of it, would have been ere this fully reviewed, and have left an utterly exhausted field for the descriptive powers of the present race of travellers. And, indeed, we cannot complain of any lack of works purporting to enlighten the British public with regard to this interesting country and people, from the grave and circumstantial journal which records, as in a ledger, every act of the tourist's life, to the light and graphic sketch of "our own correspondent." But whilst each feature of the soil and climate of the United States, her staples, her political institutions, and social condition, have been again and again described and discussed—whilst many an ingenious and interesting essay has been written on those great problems of life and morals which are there being worked out for the instruction and imitation or the warning of mankind, there is one subject which has been but cursorily touched on even in those works which more particularly dwell on the economical progress, the agriculture, and other industrial pursuits of America; and this, perhaps, in consequence of its dry and matter-of-fact character leading it to be regarded as of little interest to the general reader;—I mean the subject of the labour-saving contrivances which form so peculiar a feature of domestic and social life there. And yet that subject is one of great and growing importance to ourselves, and of still higher moment to those colonies of ours which are placed in a similar condition to the United States with respect to the labour question. For with them, as with the United States, the great problem is how to subdue nature to their purposes, and to wrest from her those fruits which are suited to the wants of man.

Now, in America, that which must strike the observing traveller with most astonishment, is the vast amount of work that has been achieved—of forest cleared, of wilderness reclaimed, of roads and railroads constructed—and the magnitude and splendour of the cities that have been built by so scanty a population in so brief a period of time. For let us enumerate a few of the marvels of American progress. In the three-quarters of a century that have elapsed since the conclusion of the War of Independence, they have overspread a territory little inferior to all Europe in extent, have dug 5000 miles of canals, constructed 16,000 miles of railways, and built some half-dozen towns rivalling in size and surpassing in magnificence any of the cities of England, London alone excepted. They have formed a mercantile marine not inferior to our own, when their lake and river, as well as ocean tonnage, is included in the comparison; they begin to rival

us in foreign commerce, and have supplanted us in the great whale fisheries; they grow a cotton crop of 3,700,000 bales, which goes far towards supplying the wants of the world; export their timber to all countries that need it; and produce a surplus of corn and provisions (in ordinary years) sufficient to glut our markets, besides feeding the population of the West Indies, and of all the eastern seabord of South America. These are great results, and our wonder is heightened when we reflect that they have been achieved beneath a climate certainly far less favourable to continuous exertion than this of England, with summers the exhausting heat of which relaxes and unnerves the physical powers, and winters which for months together bind nature in impenetrable folds of ice and snow.

Where shall we seek an explanation of these marvellous results? where but in the free energies of the vigorous and ambitious race of which they form a branch—a race endowed with powers of adaptation to circumstances unparalleled in any other people—and in the peculiar position of that race in America, planted as it was originally on a barren and inhospitable coast, which yielded scanty means of subsistence save such as the sea afforded—a condition calculated to stimulate and intensify their energies to the utmost, and to prepare them for grappling resolutely and perseveringly with the obstacles which nature and man opposed to their extension?

The strong common sense which is their birthright shows itself in a practical habit of thought, which places clearly before them the end to be attained, and enables them to adapt their means to the attainment of that end. The American, moreover, in common with the Englishman, possesses the inventive faculty in a high degree; a faculty which in the former has been quickened by the spur of necessity, and aided by the general diffusion of a solid and practical system of education, comprising instruction in the common arts of life and the physical sciences, especially mechanics and chemistry. The degree to which invention is thus stimulated may be judged from the number of patents that issue yearly in America as compared with England and France, for the American ones exceed in number the French and English together; and if the useful and practical nature of the inventions be made the criterion, the advantage will be found to be still more in their favour.

In comparing the application of this inventive faculty to the arts of life in America and in England, one simple fact must be taken into account, and that is, that whereas in England unskilled labour is procurable at a cost of 1*s.* 6*d.* or 2*s.* a day, in America the same class of labour is frequently not to be had on any terms, and, if available, costs from 4*s.* to 5*s.*: and if out-door labour is scarce and dear, in-door "help" is still more so, for

rare indeed is it to find a Yankee lass who will consent to be a drudge in any house but her own, and it is the custom to marry so early that there are but few who are not in this position. Hence the amazing variety of machines and contrivances for economizing or evading labour; hence the many ingenious methods of using up any and every source of power. Of these we occasionally see specimens in England; and some of the most important, as the reaping and mowing-machines, are even here beginning to overcome the prejudices against novelty, to move the vis inertiæ of custom, and to wrestle with the more formidable obstacles arising from the gross ignorance of the simplest mechanical principles, which, to our shame, is suffered to exist amongst the uneducated labourers of England. The history of this reaping-machine is remarkable: invented originally in Scotland, and, like many other useful inventions, long neglected, it was at length taken up in a field where the inducement to perfect it was far greater than here; brought over thence for the Exhibition of '51 as an American invention, it was admired as a curiosity, but found little suitable to English requirements; has since received various improvements, together with endless modifications of detail; and at last been brought to a high state of efficiency by various English firms, especially by that of Burgess and Key, whose reaper with the screw delivery last year carried off the prize from all the American machines in the State of New York. Nor is this a solitary instance of the neglect in England of a useful contrivance, its adoption in America, and re-introduction thence into England.

There may be seen now at Manchester an old and rusty machine, constructed years ago, which appears identical with one of the most popular of the American sewing-machines lately brought out. The humble inventor of this English machine died in poverty, whilst the American duplicate is sold by thousands, strains the powers of a vast factory to supply the demand, and is doubtless the source of great wealth to its fortunate owners, as well as of immense convenience to the ladies in a land where seamstress is a word unknown.

In reference to our immediate subject of agriculture, the faculties of the Anglo-Saxon race have been developed in each hemisphere as different exigencies have called them into action. The Englishman, having a very limited area on which to raise food for a population of 223 to the square mile, has applied his intelligence to rendering this little as productive as possible; hence all the great discoveries in agriculture, for deepening the land and increasing the fertility of the soil, are his. The American, on the other hand, having a boundless wilderness to subdue, over which his race is scattered in the proportion of less than 8 to

the square mile, or one person to 80 acres, has directed his energies to the means whereby man's feeble physical powers may be enabled to cope with so great a task; and herein has shown an originality of conception, a fertility of invention, and a boldness of enterprise truly surprising. As pioneers the Americans have no equals. Indeed, one cannot watch an American in the field without being struck with the energy and force of will which he throws into his work; *smart* is his word, *go a-head* his maxim. You feel sure that he is, if not working for himself, at least expecting to participate in the wealth he is creating; that good and plentiful food supplies his muscles, and the hope of realising fortune or independence nerves his arm. In manufactures, too, the wholesome and stimulating system of piece-work is general; and in occupations which demand enterprise and involve hazard, such as fishing and whaling, a common interest quickens the faculties of all engaged, for every one on board, from the skipper to the cabin-boy, has "a lay" in the venture; and this system is sufficient to account for the fact, so mortifying to our pride, that the Americans have taken the great whale fisheries out of our hands,—fisheries which employ 190,000 tons of shipping, and train up 15,000 or 16,000 of the hardiest and boldest seamen in the world.

My purpose is here to present a brief view of some of the most useful and generally-received machines and implements for facilitating agricultural operations; and if it shall appear, as I believe, that some of them are as well constructed and adapted to their purpose as the corresponding English ones, and at the same time are much cheaper, I hope that English implement-makers will not take offence, but will endeavour to procure their wood and other materials at such rates as, in conjunction with the greater cheapness of English labour, may enable them to meet the American exporter on equal terms in the foreign market, and effectually exclude him from our own. Nor is this hint without a meaning. It is certainly a scandal and a shame that American enterprise should drive us out of the markets of our own colonies; yet it is doing so, not in one only but in several branches of manufacture. Already the colonists of the Cape and of Australia are becoming as familiar with American ploughs as they have long been with American axes, clocks, and churns. In these countries the demand for boots and shoes is insatiable; and here again American pegged boots are superseding English sewed ones—and this not because they are cheaper, for the gold-digger is not very particular about price, but he is a shrewd judge of the article that suits him best and wears the longest. It is something more than the loss of trade which is here involved; the question is one of great national importance. It

is dangerous to the stability of the empire that we should relax our commercial hold on our colonies, and that America should take up the threads that we allow to fall from our grasp. The danger is at present the more imminent because, in consequence of the shortness of two successive harvests in the Western States, the flood of emigration thither is dammed up, and is fast rising in the Eastern cities. The great New England hive of manufacturing industry is swarming with fresh workers, and the consequent competition for employment begins to threaten us with a keener rivalry than heretofore. The game, however, is not yet lost; cheap capital and concentration of labour still incline the balance of advantages in our favour, and an intelligent and prudent use of these advantages cannot fail of giving the triumph to British industry. In the descriptions that follow I have made some use of the catalogues and lists of prices of Nourse, Mason, and Co., of Boston; Allen, of New York; Mayher and Co., all northern houses; for, be it observed, these labour-saving implements are almost confined to the Northern or free States, many of them being unknown in the South, where manual labour is at command, and where the same difficulties are experienced as in England in entrusting machinery to the management of uneducated and careless or hostile hands.

I do not flatter myself that I am about to introduce to the British Agricultural interest a set of implements altogether new to it—many of them have been already seen in England; but I am certain that the British farmer is not as familiar as he should be with the methods by which labour may be saved, and is saved elsewhere. Nor, again, do I consider all these implements as well adapted to English as they are to American necessities; but those which may be little suited to the highly-finished agriculture of England are the very things most wanted in the forests and new clearings of our colonies, where the conditions of agriculture so closely resemble those of America. Should it be said that the prejudices and obstinacy of English labourers would oppose insuperable obstacles to the introduction of some of these implements, I answer that the proper way of introducing them has not yet been tried. It is not surprising that the day-labourer, having little inducement but to get through the day's work with the least trouble, should prefer an old-fashioned tool to which he is accustomed rather than any new-fangled device, which he regards with jealousy as likely to interfere with his labour. It seems to me that the proper way to overcome these prejudices would be for the master to learn well the use of the new implement, show the labourer its superior convenience and efficacy, and make it his interest to give it a fair trial by lending him it at first for piece-work.

Let us first consider the implements made use of for clearing land.

First in importance is the American axe, so well known in every timber region of the world, consisting of a plain, narrow, wedge-shaped head, with a convex edge; inserted into which, at a point where the front is nearly balanced by the back, is a long, light handle of tough hickory, curved to fit and retain the grasp.

The effect of this weapon in the hands of a backwoodsman is surprising: every blow is planted so true, that, when you examine the stump of the fallen tree, you hardly suppose it has been felled with the axe.

Next in order comes the stump-extractor. The instrument commonly used for this purpose is a compound lever, worked by a team of oxen. The firmest-rooted stump is made the fulcrum, by means of which all the surrounding ones are extracted. This work is usually done by contract, at an expense of 2*l.* to 3*l.* an acre, varying with the number and quality of the stumps, which, for a few dollars more, are drawn aside to form fences, and these are the most durable of all dead-wood fences. There is another machine more portable than this, consisting of an iron cylinder on wheels, to which horse-power is applied as to a capstan. Hall, of Owego, New York State, is the patentee of this latter. These machines are frequently used to remove wooden houses or outbuildings, which may by their means be readily transported on rollers to a considerable distance.

Next in order in clearing land comes the root-puller, a most useful implement for tearing out bushes, roots, and rubbish. It consists simply of four or five large strong iron claws, to which the bullock-team is attached.

The business of putting up the farmer's house is accomplished with a despatch of which we have little idea. It is usually a weather-board building (we read much of log-huts, but the thing itself is rarely seen), for the saw-mill, with steam, or water, or, in failure of these, horse-power, keeps pace with the advancing tide of population, and converts the log into boards at very trifling cost. The first good fall of snow forms a famous highway for the "lumber sleigh," and winter, which suspends operations in the field, is the time for clearing and building. Every part of the fittings or "fixings" of the house, as doors and windows, complete with their frames, mouldings, mantelpieces, and hearth-stones, cooking and parlour stoves, are furnished by the hardware merchant; and all these, being made wholesale, the iron being all castings, and the woodwork carved by machinery, are sold at very moderate prices. The furniture, too, is shaped by Blanchard's turning process, whereby an immense

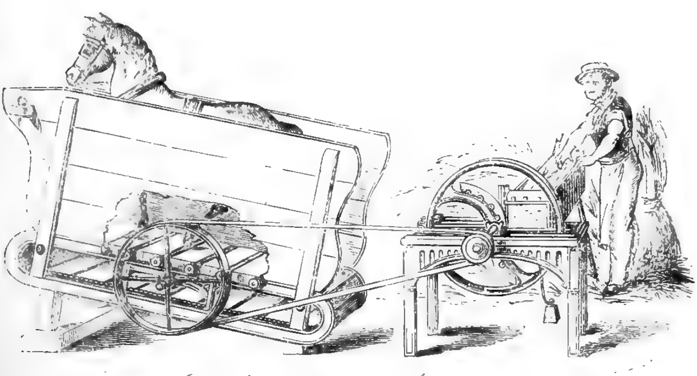
saving of labour is effected. And thus the house is completed and made habitable by the farmer and his sons, with perhaps no other help than that of a neighbour as handy as himself.

On visiting such a farm a year or two later, what are we likely to observe? We shall, in the first place, probably be shocked by the execrable state of the road that leads us there, unless, indeed, we are so fortunate as to find a plank-road—a road formed of stout boards laid on longitudinal sleepers like a floor, and kept in repair by tolls—but this is a rare luxury. The northern farmers, trusting to their sleighs in winter to carry the crop to market, and having no fancy for taxation in any shape, are contented to leave their roads in the original state of a mere track through the forest, almost impassable in wet weather. Moreover, in cases where there is every disposition to improve this track, it is not always so easy to do so, for few native Americans will undertake a species of labour which, in their minds, is associated with feelings of degradation. This difficulty has led to the contrivance of stone-breaking machines of many man-power; one of these, driven by a 6-horse power engine, I saw at work near Chicago, where it was breaking up the Niagara limestone, which forms the substratum there. It consists of two heavy iron cylinders, studded with rows of knobs of about two inches projection; the knobs on the one corresponding with the intervals on the other as they revolve in opposite directions. It was comminuting the soft limestone as fast as two men could clear it, and a travelling platform on bands was being prepared to facilitate this labour. This implement was originally invented, and has long been in use, for the purpose of breaking up the Pennsylvanian anthracite, and the greater part of the five million tons of this hard coal which is annually raised there passes between its iron teeth at a royalty of 1 cent per ton. It would, no doubt, break up the oolite and coral rag, and almost any schistose rock, but whether it could be economically employed in England is another matter. There is another stone-breaker capable of breaking up the hardest granite, hornblende, or quartz: it consists of a ponderous mass of cast-iron, against the perpendicular face of which another mass of an elbow shape is moved to and fro on a toggle or knuckle-joint; the motion is slight, but the power sufficient to crack the hardest nodules and boulders like nuts, and, as they break up, the fragments fall through a gauge. One of these, employed on the public works of the new reservoir at New York, is worked by a 12-horse power engine, and is said to answer well.

Having now fairly arrived at the farm, the first object to arrest our attention will perhaps be a railway horse-power, though these may have been already noticed at any railway station,

where they are commonly used to cut up the wood for fuel. They are of various sizes adapted for one or for two horses, or for a sheep, a dog, or a calf, any of which, when put in, have no option but to do their work, for it is a species of treadmill; and although at first sight it appears a case of cruelty, I do not believe it to be at all more so than any other kind of compulsory labour. It is not found to distress or injure the animal, and it is undoubtedly the most effectual method of applying a limited amount of animal power to such purposes as threshing, winnowing, grinding, churning, sawing wood, and all others which require rotatory motion, because, in the first place, the speed of the animal is directly imparted without the intervention of gearing to the axle of the driving-wheel; so if we suppose this to be three inches in diameter, and the circumference three feet in diameter, and that the horse walks at the rate of three miles an hour, the velocity at once given to the band on the driving-wheel is 36 miles an hour, and the force is directly proportioned to the weight of the animal, undiminished by the friction of cog-wheels.

Fig. 1.



Railway Horse-power.

The accompanying drawing (Fig. 1) will sufficiently explain the nature of the machine, which consists simply of a pen with a floor of stout slats resting on an endless web, which runs on rollers and communicates the motion given to it to the axle of the driving-wheel; the forward end of this pen is raised on a block to give it a slight inclination, and, as soon as the wheel is set at liberty, the weight of the animal moves the floor backwards with a constantly accelerating motion, which is checked only by the resistance of the work to be done, or by the application of a drag.*

* In an appendix to this paper is given a detailed calculation by Mr. Amos,

Now, suppose we compare this application of power with that of a horse in the old-fashioned lever-mill: in this railway horse-power we have seen that the speed is directly applied to the axle of the band-wheel; in the old-fashioned mill, on the contrary, the horse walks a circle of 18 or 20 yards in order to give one revolution to the axle, and this loss of speed has to be recovered by a complicated system of cog-wheels and gearing. Besides, a horse walking in a mill pulls, not at right angles to the pole (which forms the radius of the circle), but within the right angle, which involves a loss of power in proportion to his thus diminished distance from the centre of motion; the lost power being mischievously exerted in pressure on the centre, and consequent increase of friction.

The well-known economy of these "railway horse-powers" has caused them quite to supersede the old lever ones on the 200 or 300 acre farms of the Northern States; but on the large plantations of the Southern, and the great Prairie estates of the Western districts, the lever-powers, admitting as they do of the application of the entire force of the farm, are still used for threshing. The capacity of these "powers" is stated to be about 175 bushels of wheat a day threshed and winnowed, at a cost of less than 2½*d.* a bushel. I have reduced the dollars and cents to English money:—

Estimate per day of 10 *hours.*

2 horses, at 2*s.* each	=	4*s.* 0*d.*
4 hands, at 3*s.* each	=	12 0
Boarding men and horses		9 0
Cleaning up		3 6
		28*s.* 6*d.*

This is the price at which travelling machines will contract to thresh and winnow; and, if the farmer has his own machine, the cost is, of course, less. It compares very favourably with the contracts for threshing with itinerant steam-engines in England. The cost of these machines is:—

	Dolls.		£.	s.
For a 2-horse power	116	=	25	0
,, 1-horse ,, ...	85	=	17	14
,, dog or sheep power	15	=	3	0
,, 2-horse power with thresher and winnower	160	=	34	0

There are but few farmers in the Northern States that do not possess one of these "powers," and use it for the various purposes of sawing up wood, threshing and cleaning grain, grinding,

the Society's consulting engineer, showing the duty done by this and the ordinary lever horse-power, when worked under precisely similar circumstances.—H. S. THOMPSON.

crushing, root and chaff-cutting, churning, &c. They are much used by the railway companies, and sometimes even in ferry-boats for turning the paddle-wheel, and the general retention of them in a country where steam and mechanics are so well understood is not without significance.

In large concerns, as on farms which grow their thousands of bushels of grain, or at central railway stations, where hundreds of cords of wood are consumed daily, steam is, no doubt, the cheapest power that can be used, for this mighty but cumbrous agent defies the competition of bone and muscle in all cases where a large amount of regular routine work has to be accomplished, but must certainly yield to the latter the merit of readier adaptation to constantly varying requirements. On small holdings these horse-powers furnish, I firmly believe, the most economical mode of applying that force which every farm possesses, and which there can be no economy in leaving unemployed. I am convinced they would be found a great convenience to many small farmers in this country; and in many of our colonies, where steam is out of the question, they would be invaluable. Their compactness gives them a great advantage with regard to freight, to economy of space in the farmyard, and to portability, for, if wanted at a distant part of the farm to thresh an outlying crop in the field, the "power" is forthwith put into a waggon and drawn to the spot by the horses which, when arrived there, work it.

The straw from the threshing-machine is very commonly conveyed to the rick by an endless band or web, which is carried over a roller on the threshing-machine and another roller on the rick, and moved by a belt from the horse-power, and thus delivers the straw at a distance of 18 or 20 feet with the help of only one man to distribute it and attend to the top roller.

The cost of this simple and useful contrivance is 15 dollars (3*l.*). I see an English machine, for effecting the same object, advertised at the price of from 51*l.* to 62*l.*, according to the distance of the delivery! The saving in labour effected by this plan is very great.

Let us next inquire how the crop is cut, or "harvested," as the term is there.

It is a mistake to suppose that reaping-machines are in general use in the States, their principal service is in the vast grain-fields of the Western or Prairie States, where despatch is of the utmost importance, and hired labour hardly known. In the great and populous States of New York, Pennsylvania, and New Jersey, the grain scythe and cradle is the implement wherewith most of the grain is levelled: a most efficient implement it is, and a most useful one it would prove if introduced into this country, for it is

as superior to the plain English scythe and bow as the Minié rifle to the old musket.

The length of the scythe is 4 feet; the cradle is formed of five finely-tapered ash fingers, of length and curve corresponding to the blade; the snaith, as light as is consistent with strength, is bent into an elegant curve: it is a perfect implement of its kind; price five dollars (1*l.*).

It is common in these Eastern States to cut the grain by harvesting "bees"—that is to say, the farmer collects as many of his neighbours as he can, each of whom brings his own favourite "cradle," the snaith of which is curved to his fancy; and it is refreshing to see with what a will a large company thus formed mow down the grain. On these occasions each man "calculates" to cut his two acres a day; some men will do more, and the quantity that is credibly reported to have been cut in the day for a wager would not be believed in England: two acres, however, are a fair average for men working in company. In the South, a negro's task is usually one acre a day, a fair criterion of the difference between free and slave labour. It must be borne in mind that the average crops in the States are much lighter than in England, 20 bushels of wheat being there considered a good crop, and 25 a large one; the average quantity of straw is not so much less than in England, the difference being principally caused by the shortness and want of filling in the ear, owing to the rapid ripening of the grain beneath their hot sun.

The use of this grain scythe, undoubtedly, requires a peculiar knack; it is accomplished with a great swing of the body, and the grain is tipped out of the cradle at the end of each cut; but if our people could learn the art of using it, it would prove a most valuable substitute for the sickle, or the common scythe, particularly in the Eastern counties, and still more in the Cape and Australian colonies, where the crops are not apt to be laid. In fact, one cannot watch the operations in an American harvest field without being impressed with a conviction that, if English farmers and our colonists are to compete with the American in growing corn, they must adopt some of those implements which American ingenuity stimulated by necessity has already invented and proved.

It is not the grain-cradles alone that are superior to the corresponding implements of this country, but the common tools, such as hay-forks and rakes, dung-forks, and digging-forks, display a lightness combined with strength, a beauty of proportion and high finish, which is not seen even in our most improved ones, and is far superior indeed to those commonly used here. Their best five-pronged forks are cut out of a single piece of steel, and when swung round and dashed against the floor, a common test,

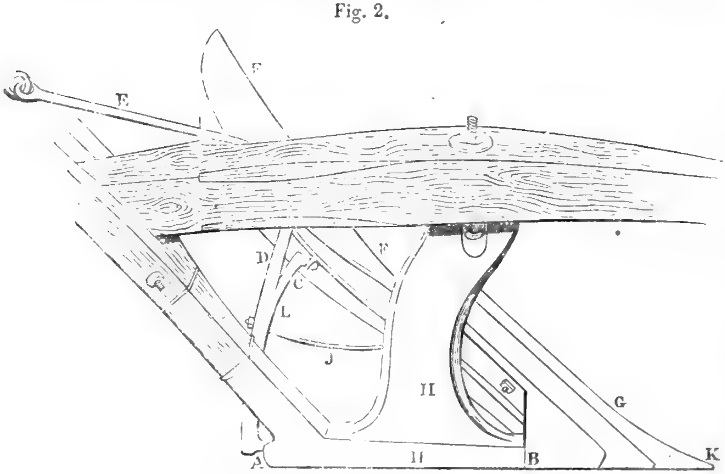
ring like a tuning-fork: lightness and handiness are particularly attended to in these; whereas here it seems to be forgotten that half a pound of superfluous weight lifted only each quarter of a minute makes a difference of at least half a ton in the working day, and lessens thus much the quantity of work that the labourer can perform in the day. It is to be feared, that unless our manufacturers vie with these models they will lose the colonial and foreign markets. There is an implement much used in America, instead of the dung-fork, in mixing manure heaps, removing rubbish, &c., called an ox-shovel. It is a cast-iron scraper with handles to guide it from behind: when these handles are pressed down the shovel glides over the ground, and when they are raised the edge catches the ground, and, as the horse or ox continues to draw, turns it over. The price is about five dollars (1*l.*).

It requires some hardihood to say a word in commendation of American ploughs, when one remembers the derision with which they were greeted in England at the time of the Great Exhibition. Strange to say, however, the ridicule they excited here has not led to their abandonment in America, or the substitution of English models in their stead—and yet the Americans are a shrewd people. Certainly the plough is an implement that has not suffered from want of attention in America; indeed, the true principle of the mouldboard is believed to have been first thought out and made known to the world by a distinguished American, their great President Jefferson, in a letter to Sir John Sinclair; and a brass model of a plough, designed by him, is in the possession of the American Institute at New York. The general shape and proportions of this plough may be recognised in those of the present day, which are altogether shorter and more compact than ours—shorter in the proportion of 2 to 3. This difference is caused by the beam being shorter, and the stilts (which as well as the beam are usually of wood) being more curved and set more upright than ours, so that the ploughman is more over his work. This form is, perhaps, not so well adapted as the English for running a straight furrow, but then they maintain that it is better adapted for leaving an even trench. Certain it is, that the best English ploughs in English hands have failed in competition with American ploughs on American soil in the opinion of American judges; perhaps, if the conditions were reversed, the results would also be reversed. The share of an American plough is usually wider than the English, taking in commonly from 10 to 12 inches, and in the Prairie ploughs frequently 18 inches; this great width, with a team of adequate strength, makes short work of an acre. The mouldboard is of corresponding height, to turn over this great width. The short

bold curve which is usually given to this mouldboard is not adapted to lay the even unbroken lap so much admired in England, but leaves the land in a more broken and pulverized state. It would probably be but ill-suited to our stiff clays. The great manufacturers, however, make them of all shapes and dimensions to suit all soils and every taste. The coulter is sometimes separate, sometimes inserted into a prolongation of the share. This is called the lock coulter, and is useful in newly-broken land to prevent the plough from being "choked" with rubbish; sometimes it is a sharp steel disk, sometimes a perpendicular projection from the share ("the fin share.")

Swing ploughs are the rule, and it is rare to see more wheels than one small one beneath the end of the beam. The share, mouldboard, and land side are usually made of chilled cast-iron; but in the Prairie States the mouldboard is of chilled steel, as iron will not scour in the rich vegetable mould of the Prairies. The wooden beam is generally reinforced by an iron draught rod. The price of these ploughs by the best makers varies, according to size, from 3 dollars to 21 dollars, which is the price of the largest steel ploughs; but a very good plough, complete, may generally be purchased for 10 dollars (2*l.*), or about one-half the price of the same class of English ploughs. Their compactness

Fig. 2.



American Turn-wrest Plough.

Pivot at A and B, around which the mouldboard, F, with share, G K, turns underneath H, on unhooking the rod, E, which holds the mouldboard in its place when the plough is at work. L is the connecting-rod, by which at A and C and end of D the mouldboard is attached to the hinge, A B, around which it turns. The rod, J, holds this swivel-rod, L, in its place. Length from A to B, 13 inches; A to K, 23 inches.

and portability give them a great advantage in competition with ours in the colonial market: the best English ploughs (measuring four yards in length) do not admit of being shortened, whereas the stilts of an American plough can be taken out, and it will then occupy only two yards in length, and the freight is consequently reduced to one-half of that of its English competitor.

The turnover or hill-side plough, which is so generally used in the mountainous regions, deserves some notice here. It is so simple, ingenious, and useful as to excite surprise that it has not become known in England. Its principal use is to plough across hill-sides, always throwing the furrow down hill, instead of running it up and down the slope, which, besides the inconvenience on steep land, occasions in the rainy season great washing of the soil. It is also used on level land whenever it is desirable to avoid ridges. These objects are effected by making the upper and lower sides of the share and of the mouldboard precisely similar, so that each in turn may form the sole, and fixing it on a pivot, which admits of its being instantly thrown round, beneath the beam, from right to left or from left to right, and forming either a right-hand or a left-hand plough. (See Fig. 2.) Left-hand ploughs are used almost exclusively in those parts of the States which have been settled by Germans, and they stoutly maintain the superior convenience of this plan, from its enabling the ploughman to guide the furrow horse with his left hand, whilst his right hand commands the plough—"keep the furrow horse in the furrow, and the plough must go straight" is quite a proverb with them. The team almost invariably consists of two horses abreast, which are kept at their due distance by a "Jockey Stick," extending from the collar of one to the bit of the other.

The horses that one sees at the plough on these northern farms exhibit far more blood and breeding than the average of English farm-horses; in fact, the small farmer's team consists of a well-broke docile pair, which draws his "trotting waggon" in summer and his sleigh in winter (for every farmer has his carriage, and seldom thinks of walking any distance), conveys his crop to market, tills the land, and at odd times is clapped into the horse-power to perform any needful job; and by the smartness which the American throws into all the operations of the farm, the various methods by which he husbands strength and economizes time, as exemplified particularly in the lightness of his vehicles, which he drives at a trot when empty, he manages to cultivate with a single pair far more land than would be thought possible in England. Nor do I consider that the objection can be fairly urged that they only half cultivate the land and get only half a crop: the various conditions of soil, climate, and value of land, so different from ours, complicate the question; but when all allow-

ances are made, I believe it will be found that with equal strength they get through more work and raise a far larger amount of produce than we do in England. And here let me observe that mules are fast superseding horses on the large farms; it is a rare thing to see a horse on any of the great cotton, rice, or sugar plantations. There can be no doubt of the greater economy of mules: they require considerably less food for accomplishing an equal amount of work, and this food may be of a coarser kind, so that on the whole their keep is considered to cost one-third less than that of a horse of equal weight; they are much hardier than horses, and their longevity is surprising. It seems probable that in course of time they will take the place of horses as the common drudges of the farm. By careful breeding their size has been much increased; some of them indeed are truly noble animals, and command in the Southern States higher prices than horses of equal size. The original introduction of them into America is attributed to the great father of the country, Washington; and the best blood claims descent from a pair of jacks presented to him by the King of Spain.

Having mentioned the lightness of the vehicles, let me add a few words more on this subject. I have said that the northern farmer, reckoning as he may with confidence on a smooth surface of frozen snow during several months in the year, over which to sledge his crops to the nearest railway, river, or canal, pays but little attention to the condition of the roads, and these are accordingly left in such a state that they would be impassable to our heavy carts and 25 cwt. waggons. To meet the difficulties of the case for summer travelling, the American pays the utmost attention to lightness in the construction of his conveyances. Carts are seldom seen, but the waggons—very unlike the ponderous machines used in England—hardly exceed the weight of our carts, and the advantage gained on soft ground by the distribution of the weight on four points, instead of two, is sufficiently obvious. The essentials of an American waggon are two pair of wheels of almost equal height, with scarcely more material in them than in our carriage-wheels; but this material is most judiciously distributed, and put together with great regard to stability; the felloes, instead of being composed of six or more pieces cut out of the solid log, and therefore partly cut across the grain, are of two pieces of their light tough hickory, bent by steaming, and firmly clamped and mortised together; a frame is set on the iron axles, into which boards are slipped as occasion requires for forming the "box;" it is provided with a pole or "tongue" instead of shafts (for two horses abreast is the almost invariable rule), and a perch, which, in the lumber districts, is made to admit of extension as in our drays; the body is generally

put on elliptical steel springs, which are sometimes reinforced by a lump of India rubber secured in the centre. If the waggon is not provided with springs, at all events the driver takes good care to have them beneath his seat. The kind of spring most commonly used in the lighter vehicles throughout the country, in the stage-coaches, vans, and the New England buggies, is the "pole and thorough brace," consisting of a tough elastic ash or hickory pole, rigid at one end with the framework or bed of the carriage, and a stout leather thong extending from the other extremity of the pole to a hook in the bed or framework. This thong takes the weight of the body of the carriage, and thus forms the strongest and best spring for rough roads, as has been abundantly proved in our Australian gold colonies, where steel springs have been found worthless for rapid motion; and carriages hung on these leather thongs now convey the fortunate diggers over the rough lava-strewn plains at a pace that might astonish even the veterans of the English mail-coaches.

I am quite aware to what an amount of criticism I expose myself by venturing to say a word in justification of the use of waggons, now that their cause has been by a high authority in England formally put out of court. I do maintain, nevertheless, that the light American waggons may be used with advantage on roads that would be impracticable for our carts, and more particularly in hilly districts. The same simplicity or rudeness (as the reader pleases) which has marked all the operations hitherto reviewed, characterizes the transport of the grain from first to last. Let us suppose that it has been grown in far-off Illinois, 1000 miles west of New York,—how does it reach the consumer there? It never comes in contact with a sack, but is dealt with altogether in bulk. Conveyed loose in the waggon-box (which is made of tongued and grooved boards slipped into the frame) to the nearest railway or boat, it is there measured off as it is poured into the grain-car or the hold—a receipt taken and forwarded to the consignee at Chicago; there it is either poured straight into some schooner or steamer's hold, or, if required to be stored, hoisted by an "elevator" to the bin of some tall warehouse, whence it is shot into the vessel's hold just as fast as it can be measured in the transit. These operations are performed with so little noise or bustle that you are hardly aware that anything is going on, and the despatch is such that a schooner laden with 12,000 bushels of grain will discharge it all by means of elevators in half a day. The cost of the passage of grain through a warehouse, or "handling" as it is termed, together with storage for a reasonable time, is only 1½ cents or three farthings a bushel, and this charge leaves a very handsome profit. But we have not yet got our grain to New York.

After a voyage of 800 miles through the great lakes it reaches Buffalo, there is transferred by elevators again to barges, which convey it by the Erie Canal to Albany, and thence down the Hudson towed by steam to New York. And what has this long transport of above 1200 miles, together with the various transshipments, cost?—the expense may generally be set down at 14 cents (7*d.*) per bushel. What would it have cost if carried, in the orthodox English way in sacks, out of the hold on men's backs, then in a ponderous waggon for several miles, &c. &c.?

Having thus landed the corn at New York (for shipment to England, at the cost of another 6*d.* or 7*d.*), let us return to the farm.

The harrow most used is the Geddes's folding one, of a V-shape, divided longitudinally, and the two parts hinged together, so as to admit of either being instantly raised by the driver, a very convenient form in fields encumbered with stumps or boulders, and also for getting rid of twitch and rubbish. The weeding of the crops is, as may be supposed, almost entirely performed by the horse-hoe, and that in most request is a light and simple one, costing 8 dollars. In planting the Indian corn, which is by far their largest crop, particular attention is paid to setting the plants at regular intervals, so as to admit of the horse-hoe and the corn-hiller traversing the field in every direction. The corn or potato-hiller is an implement furnished with mouldboards which may be set to converge at any angle, so as to throw up as wide or narrow a ridge as may be desired.

The entire system of American agriculture favours this substitution of animal for manual labour. Where wheat is grown as the principal crop, the rotation is red clover, wheat, Indian corn, wheat; or else clover, and white crop, alternately; the clover being sown in spring and ploughed in before ripening its seed, together with the weeds, which soon perish beneath the parching heats of summer, and leave the land clean for the autumn sowing. The corn crop answers to our turnip crop, is, like it, a cleansing one, and is at least parallel to it in importance, the animals on the farm being almost entirely kept during the long winter on this grain, together with its husks and stalk, which are full of saccharine matter. The negroes in the South live entirely on corn and pork.

Such a rotation as this is calculated to keep the land in heart with but little labour, and to economize the carting out of manure, which is usually done, if at all, but once in the rotation—preparatory to the corn crop.

This crop (corn) furnishes an instance of the great economy of labour effected by the use of a simple machine. The annual cost of shelling the corn from the cob by hand was estimated by a political economist some years ago at four millions of dollars;

it is now all done by corn-shellers, and the husk stripped off by husking-machines, at least in the Northern States.

The corn is also frequently ground on the farm, both for feed and for household purposes, by cast-iron mills, on the principle of the coffee-mill. The little giant-mill is one in which the application of the power to the work is delightfully direct. Its capacity is stated to be, with 2 horses, 6 bushels per hour, *i.e.* 60 bushels per day. For finer grinding, a cutting-mill, invented by Blanchard, seems likely to prove the most rapid and effective for farm purposes.

The mention of cattle-feed suggests the subject of hay. Timothy is the favourite artificial grass in America, from its standing drought well and yielding largely; it grows high, with but little bottom, and hence does not require to be shaven so closely as English meadow-grass. The hay is generally stacked under a wooden roof, which is made to slide up and down between four poles, over which it is counterpoised: this is called a hay-barrack, and affords great convenience, since, in case of wet coming on before the stack is completed, the roof can be immediately lowered on that which is deposited. A permanent roof of this kind must certainly be cheaper than an annual thatching; perhaps in England felt or tarpauling might be cheaper than boards. In Pennsylvania the hay is usually stored in a large barn, built generally on a hill-side, with a "barn cellar" below to contain the cattle, advantage being taken of the slope to draw the load into the barn from the higher ground, whilst the cellar is flush with the lower ground, and open on that side. This affords great warmth. Where the hill-side is wanting, the hay is hoisted up into the barn by a rope rove through a block suspended from the roof-tree: to one end of this rope is attached one or a couple of large 4-toothed unloading forks, rake-shaped, capable of raising 4 to 5 cwt. at once; to the other end the horses are attached, and thus the same power that has drawn the load speedily discharges it. There is generally a catch on the fork-handle, which releases and deposits the load on the jerking of a line attached to it. The blocks used for all such purposes are patent blocks, *i.e.* fitted with friction rollers round the pin, as are most of the leading blocks in American merchant ships. These blocks are rather more expensive than the plain ones, but undoubtedly prove economical in the end, by sparing the strength of the men, and thus enabling their ships to sail shorter-manned than ours; and this consideration for the men, as shown in other ways besides the blocks and such-like labour-aiding contrivances, in the accommodations for the men and the superior quality of their provisions, undoubtedly contributes not a little towards rendering their marine popular amongst seamen, in spite of the

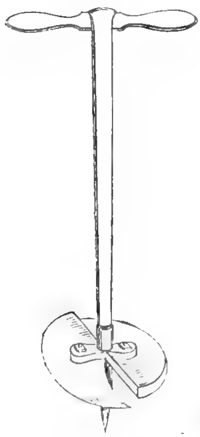
severity of the discipline on board their ships. But we are wandering from the farm.

Having now noticed a few of the more ordinary implements, let us turn to the fences: these are slovenly to an English eye, being almost invariably composed of roughly-split rails laid zigzag,—the eternal "snake fence." But, on the more finished farms, and generally about the house, this gives way to post and rail. For making the post-holes, they have an earth-auger (Fig. 3), which is a great assistance in stiff clay and tenacious soils.

For mortising the posts themselves they use a boring-machine (Fig. 4), worked by handles at right angles to the tool, to which the motion is imparted by bevelled wheels: this greatly facilitates the labour of boring. The carpenter lays the post down, kneels on the framework of the borer, and turns the handles, one with each hand: it saves the screwing round of the wrist and laborious pressure, the leverage giving great aid to the workman, and the tool cannot but go straight through the wood. This instrument is much used for boring the bolt-holes in railway sleepers after they are laid down.

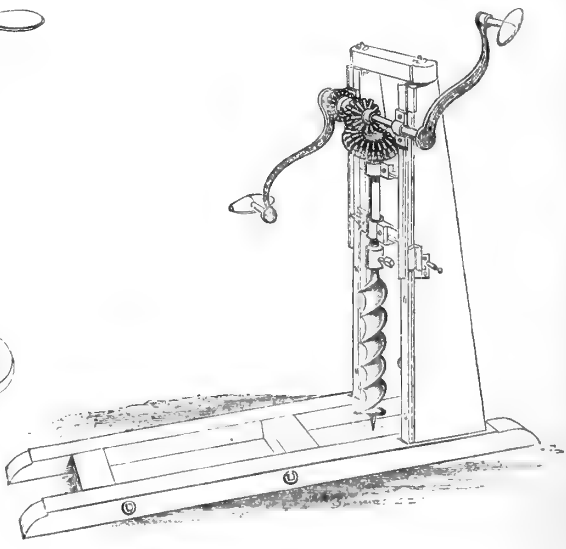
There is besides this a complete portable mortising-machine, worked by hand or foot. The tenoning-machine is another implement of this class, for which mankind is indebted to American invention. Timber fences, which are so much the most readily formed on first clearing the farm, have been perpetuated mainly

Fig. 3.



Earth Auger.

Fig. 4.



Boring machine.

owing to the difficulty experienced in raising hedges. Quick does not succeed well in a hot and dry climate; buckthorn does better, but is not general: but it is probable that two indigenous thorny plants, the Osage orange and the Cherokee rose, will be found to answer the purpose well. I mention this, as I have done various other points, in the hope that this paper may be seen by, and furnish a hint or two to, some of our colonists who dwell in lands resembling in climate and other conditions the United States.

To return to the subject of implements. The common hay and stubble spring-tooth horse rake is a cheap and useful implement, in which the requisite degree of elasticity is given to the teeth by the simple method of coiling the wire, just as the spring in which a bell is hung is coiled. The price of this is 30*s.* This and a more elaborate iron rake, resembling Page's, are superseding the old wooden turn-over hay-rake, which, though ingenious and serviceable, drags heavily on the ground. For drilling and for broadcast sowing they have horse machines like ours, but a simple V-shaped wooden trough, perforated with holes, is sometimes made to answer the purpose: it is carried in front of the sower, slung by a belt over his shoulders, and as he shakes it in walking the seed falls through. This "sower" is sometimes improved by being traversed by a wooden roller with an India-rubber band wound spirally round it, transforming it into an Archimedean screw, which is made to revolve and brush the seed out by turning a handle.

The weeding among crops sown broadcast is performed with a hand "scuffle" hoe; the double-edged blade of which, set at an angle of 45° with the handle, enables the backward as well as forward stroke to tell.

An implement for ploughing up potatoes has been lately invented, and is already coming into extensive use. It resembles a double mould-board plough, the peculiarity being that the mould-board has longitudinal slots, through which the earth passes, whilst the potatoes are thrown out on each side. This, by substituting a common double mould-board, is rendered serviceable for hilling up. The price is 8 to 10 dolls., about 2*l.* If it does its work well (and I believe it gives satisfaction), it is much more economical than the lately-invented English potato-digger.

And if it be argued, as it frequently is with reference to this question of first cost, that the English agriculturist is determined to have the best implement, cost what it may, I answer that this recklessness of expense may be carried too far. In the case of permanent structures, expense at first frequently proves economy in the end; but when we consider that the best of implements

suffer from wear and tear and corrosion, that the consumption of iron alone per acre in England and France is from 12 lbs. to 16 lbs. per annum, and that the interest on capital employed forms no inconsiderable item in the balance sheet, one cannot but believe that it must make some difference in the farmer's profits whether he pays for his ploughs 2*l.* or 4*l.*, for his straw elevator 3*l.* or 60*l.*, and for a potato-digger 2*l.* or 17*l.*, the price of the Scottish one.

Various minor implements or appliances of well-known principles will infallibly meet the eye in every American establishment, all tending to the one end of saving work and trouble. Many of these are worthy of notice. The mere mention of some of them will be sufficiently suggestive, such as are friction rollers for the axis of the grindstone to revolve on; rollers on which to slide back the barn door—a method very preferable to hanging it on hinges; the water-ram, for raising water by its own impulse from the neighbouring brook (these, so little known in England, are very common there); washing-machines, and revolving arms for hastening the process of drying the clothes hung on them; butter-workers and self-acting cheese-presses; lifts, which are much used in lofty houses for raising all weighty things to the different floors; cooking-stoves for facilitating the preparation of the food and economizing fuel: and let us not forget the ingenious apple-parers for peeling, coring, and slicing up apples for the pie; machines for mincing meat and stuffing sausages—these, and many other contrivances which it would be tedious to enumerate, all bear testimony to the unparalleled ingenuity which our cousins have displayed in finding substitutes for that labour, the scarcity of which is the great drawback to their material prosperity.

Kegworth, Derby.

Report on the Horse-power patented by ISAAC HARTAS, *of Wrelton Hall, Pickering, Yorkshire, and exhibited at the Ripon Meeting of the Yorkshire Agricultural Society.*

A single horse-works, by Isaac Hartas, of Pickering, attracted a great deal of attention. The principle of this machine has been used for some time in America. It consists of a moveable platform attached to an endless chain passing over rollers at each end; this endless platform is placed so as to form an inclined plane, upon which the horse walks, and the platform recedes beneath the horse's feet. The platform has cogged "racks" attached to it, which gear into a toothed wheel, which drives machinery. In this case it drove a small thrashing-machine,

and had also a small chaff-cutter attached to it. The whole arrangement is very simple. As some discussion took place as to the usual effect a horse could produce when working with this machine, some careful experiments were made on the machine in question, and on a well-made horse-works, in which the horse walked round the circle in the usual way. In the first experiment, one of Richmond and Chandler's oat-crushers or linseed mills was attached to the horse-works, with a dynamometer intervening to record the work done. The horse, walking at the rate of 2·04 miles per hour, did work equivalent to the raising of 33,110 lbs. one foot high per minute. During this experiment, at the rate the horse walked, and taking into consideration the angle of elevation of the platform, the horse would have raised himself to the height of 33·66 feet in one minute—that is, had the platform been stationary and prolonged indefinitely. The horse with his harness weighing 1084·5 lbs., and this multiplied by 33·66 feet, the height the horse would have raised himself equals 36,504 lbs., lifted one foot high per minute. In the second experiment, the horse walked 1·7 mile per hour, and did work, as shown by the dynamometer, equivalent to raising 31,350 lbs. one foot high per minute, during which time he would have climbed 28·21 feet, which is equivalent to the raising of 30,594 lbs. one foot high per minute. In this experiment the horse walked and worked exceedingly steadily, and the work he did at that time (31,350 lbs. lifted one foot per minute) fairly represented the work a horse can do by this machine. To compare the above with a common horse-works, the horse used in the last experiment was yoked with another of similar power and quality, to a two-horse power works, made by Mr. John Barker, of Dunnington. The power was applied to the same mill and dynamometer, and the work done by each horse was equivalent to 26,500 lbs. lifted one foot high per minute, being about 16 per cent. less than the duty done by Mr. Hartas' horse-works. It was apparent to observers that the horses worked equally in all the experiments, and every care the circumstances afforded was taken to obtain the best results.

C. E. Amos.

X.—*On the Composition of a Mangold-Wurzel kept for Two Years.* By Dr. Augustus Voelcker.

Some time ago Mr. Farmer of Fazeley exhibited to the Council a mangold-wurzel, which was grown by him and stored in 1857, and again stored amongst other roots in 1858. When examined in May, 1859, it was found apparently quite sound. It thus kept apparently healthy for about two years.

It was conceived that the analysis of this root might be of some interest, and I therefore submitted it to a careful and detailed analysis. The following is the general analysis of this root:—

	In natural state.	Calculated dry. Dried at 212° Fah.
Water	92·25	—
Soluble organic matter	3·27	42·32
Soluble mineral matter	1·23	15·87
Insoluble organic matter	3·12	40·16
Insoluble mineral matter	·13	1·65
	100·00	100·00

The more minute examination of the same root yielded the subjoined analytical results:—

Detailed Composition.

	In natural state.	Calculated dry. Dried at 212° Fah.
Water	92·25	—
*Soluble protein compounds.. ..	·97	12·51
Sugar, gum, and pectin	4·08	52·67
Soluble inorganic salts	1·23	15·87
†Insoluble protein compounds ..	·16	2·06
Woody fibre (cellulose)	1·18	15·22
Insoluble mineral matter	·13	1·67
	100·00	100·00
*Containing nitrogen	·155	2·00
†Containing nitrogen	·025	·32
Total nitrogen	·18	2·32

The juice of this root had a specific gravity of 1·022. The preceding analytical results suggest the following remarks:—

1. It will be noticed that the proportion of water in this root is very much larger than in roots of fair average quality. Indeed there is fully as much water in this root as in common white turnips. In good mangolds the proportion of water amounts to 88 or 89 per cent., and sometimes is even lower than 88 per cent.

2. The proportion of mineral matter or ash in this root likewise is very large, it being much more considerable than in good mangolds.

3. It will be noticed that nearly the whole of the mineral matter consists of soluble salts. As the root tasted rather saltish, I thought it worth while to determine the amount of common salt in it, and was surprised to find no less than ·64 of a grain of common salt in the root in its natural state, or 8·25 grains in the dried root. More than half of the soluble mineral matter found in this root therefore consisted of salt. In the growth of the mangolds, of which the root examined by me was a specimen, much salt was evidently employed as a manure.

4. The proportion of nitrogen in the root is rather above the average.

The legitimate conclusion that can be deduced from these observations is that this root, although apparently sound, has undergone some changes, which have deteriorated its feeding qualities. It is, however, no doubt still sufficiently well preserved, and contains sufficient nutritive matter to be given to cattle with great advantage.

I may observe that I have examined roots late in the season, after having been stored for seven months, and that in these roots I have always found less water, sometimes considerably less than in the roots at the time when they were stored in autumn.

The large quantity of water (92 per cent.) in the root which has been kept for two years, is larger than in the worst grown mangolds taken fresh from the field. There cannot therefore remain much doubt that keeping for two years has had an unfavourable effect upon the constitution of this root.

Again, the large amount of mineral matter in this mangold appears to me to indicate that probably a considerable quantity of the dry organic matter has entered into fermentation and escaped in a gaseous state. We know that roots put in heaps ferment, and also that every kind of fermentation if prolonged for any considerable time is accompanied with loss of substance. The fact that this mangold wurzel contained a great deal of ash, seems to me to imply that the fermentation in this case has been attended with considerable loss in feeding substances. The mineral portion cannot escape by evaporation, nor is it affected by fermentation; in the measure therefore in which the organic portion of the root diminished, that of the mineral portion must have increased.

It is to be regretted that a number of mangolds of the growth of 1857 were not weighed and one or two examined at the time when the crop was stored away, and again weighed and analysed at the end of the first year's storage, and also at the end of the second year. We might then have traced more definitively the changes in the root, which I feel assured have taken place. This is a subject well worthy the notice of root-growers; for it must be a matter of considerable interest to practical men to know how long mangolds can be stored without suffering injury, and it is likewise of importance to determine by precise experiments by what time stored roots have acquired their maximum feeding properties.

Although I am of opinion that it is bad policy to keep mangold for two years, it is still an interesting fact that this mangold could be kept apparently sound for so long a time. The question arises:—Do all mangolds when properly stored keep equally well? I confess that I doubt this, and am inclined to think that the large quantity of salt in this mangold may have had some

share in preserving the root. Should it be found that mangolds manured with salt keep much better than roots without salt, additional inducement is offered to the farmer not to stint his mangold in salt. This leads me in conclusion to express the opinion that the character of the manures which are used for mangolds has a material influence on their composition, which no doubt must affect likewise their keeping qualities.

In the absence of precise information and experiments, I abstain from further speculating on this subject, and allude to it here mainly for the purpose of showing how desirable it is that the whole question should be thoroughly investigated. This, I believe, can only be done properly by a systematic series of practical and analytical experiments.

Royal Agricultural College, Cirencester.

XI.—*On the Changes which Liquid Manure undergoes in contact with different Soils of known composition.* By Dr. Augustus Voelcker.

In a paper 'On Farmyard Manure and the Drainings of Dung-heaps,' published in vol. xviii., of this Journal, I communicated the results of two experiments, which showed that drainings from dung-heaps, in passing through soils of known composition, undergo a series of remarkable and important changes. Since the publication of this paper I have been actively engaged in following up this interesting inquiry; and, at the request of the Council of the Royal Agricultural Society, have now the pleasure of laying before the readers of the Journal the results of my recent researches on the subject.

The liquid manure employed in the following four experiments contained in an imperial gallon:—

		Grains.
Ammonia (in the state of carbonate and humate of ammonia)		35·58
Organic matters		20·59
Containing 1·49 of nitrogen. Equal to 1·81 of ammonia.		
Inorganic matters (ash)	91·27	
Consisting of :—		
Soluble silica		2·34
Lime		11·48
Magnesia		2·87
Potash		16·92
Chloride of potassium		2·74
Chloride of sodium		40·35
Phosphoric acid		4·83
Sulphuric acid		3·94
Carbonic acid and loss		5·80
		147·44

In the fifth experiment it was thought desirable to use a very dilute fertilizing mixture; and, consequently, liquid manure, kindly supplied to me by Mr. Mechi, of Tiptree-hall, was selected. The composition of this liquid manure will be stated in a subsequent page.

The first filtration experiment was made with a soil from field No. 19 of the Royal Agricultural College Farm, Cirencester.

Submitted to a mechanical analysis, this soil was found to contain, in 100 parts,—

Moisture	1·51
Organic matter	11·08
Carbonate of lime	10·82
Clay	52·06
Sand	24·53
	100·00

It appears from this that the soil in question is a calcareous clay. In wet weather it is very sticky and stiff; worked in dry weather it breaks up in hard unmanageable lumps. By autumn cultivation its physical properties have been considerably improved. A portion of the soil, taken from a large well-prepared sample, yielded, on being submitted to chemical analysis, the following results:—

Moisture	1·51
Organic matter and water of combination	11·08
Oxides of iron and alumina	14·25
Carbonate of lime	10·82
Sulphate of lime	·71
Magnesia	·51
Potash (in acid solution)	·32
Soda (in acid solution)	·05
Phosphoric acid	·10
Insoluble silicates and sand (chiefly clay)	61·78
	101·13

This soil was mixed with liquid manure in the proportion of 2000 grains of soil to 7000 grains of perfectly clear liquid manure, the composition of which has just been stated. After shaking the soil and liquid together, and repeating this at intervals several times, the whole was allowed to settle; after a lapse of 24 hours the tolerably clear liquid was syphoned off. Notwithstanding that the filtration through fine filtering-paper was repeated many times, the liquid remained somewhat turbid. It was found, however, that a perfectly clear liquid could be obtained by allowing the filtered liquid to subside for eight days, and then carefully pouring off the clear liquid from the small deposit. This course has been followed in all subsequent experiments, and yielded tolerably satisfactory results.

The liquid manure originally had a brown colour; after filtration through the soil the colour of the liquid was scarcely less deep.

A portion of the clear liquid was evaporated to dryness, and in the residue the amount of fixed ammonia and nitrogen determined by combustion with soda-lime.

Another portion of the filtered liquid was supersaturated with hydrochloric acid, and thereby the volatile carbonate of ammonia and the humates and ulmates of ammonia, which lose ammonia on heating, were converted into chloride of ammonia. Evaporated to dryness on the water-bath, the acid liquid left a residue which, on burning with soda-lime, gave the total amount of nitrogen in the liquid. By deducting the amount of nitrogen found in the residue left on evaporation without acid from the total quantity of nitrogen, and calculating the remainder as ammonia, the proportion of ammonia existing as carbonate and as humate or ulmate of ammonia was determined.

A third portion of the filtered liquid was evaporated to dryness, the residue weighed, and afterwards burned in a platinum capsule at a moderate heat. The remaining ash was subsequently carefully analysed, according to well-known processes that need not be described here in detail.

This ash was found to consist, in 100 parts, of—

Soluble silica	·90
Oxide of iron	3·24
Lime	28·52
Magnesia	1·49
Potash	4·33
Chloride of sodium	42·36
Phosphoric acid	·77
Sulphuric acid	3·67
Carbonic acid and loss	14·72
	100·00

The solid matter in the liquid manure, left in contact with soil for 24 hours, had the following composition:—

Organic matter		30·66
Containing 1·62 of nitrogen.		
Inorganic matter	69·34	
Consisting of:—		
Soluble silica		·62
Oxide of iron		2·24
Lime		19·77
Magnesia		1·03
Potash		3·00
Chloride of Sodium		29·37
Phosphoric acid		·53
Sulphuric acid		2·54
Carbonic acid and loss		10·24
		100·00

According to these data, an imperial gallon of liquid manure, mixed in the proportion of seven parts (by weight) to two parts (by weight) of soil, and filtered off after 24 hours, had the following composition:—

			Grains.
*Water and volatile compounds of ammonia			69,886·60
†Organic matters			34·77
Inorganic matters	78·63		
Consisting of :—			
Soluble silica		·70	
Oxide of iron		2·55	
Lime		22·42	
Magnesia		1·17	
Potash		3·40	
Chloride of sodium		33·31	
Phosphoric acid		·60	
Sulphuric acid		2·88	
Carbonic acid and loss		11·60	
			70,000·00

* Containing ammonia (as carbonate and humate and ulmate of ammonia)	20·81
† Containing nitrogen	1·84
Equal to ammonia	2·23

The remarkable changes which took place in the composition of the original liquid when left in contact with the Cirencester soil will appear by a study of the subjoined tabular statement, in which the composition of the liquid manure before and after contact with the soil is given, and which also states the gain or loss in the several constituents found in the filtered liquid.

Composition of Liquid Manure before and after Filtration through soil from field No. 19, *Royal Agricultural College Farm, Cirencester.*

An imperial gallon contains :—	Before contact with Soil.	After contact with Soil.	Gain or Loss.
Water and volatile ammonia compounds	69,888·14	69,886·60	−1·54
Containing :—			
Ammonia, as carbonate and humate of ammonia	(35·58)	(20·81)	−14·77
Organic matters	20·59	34·77	+14·18
Containing nitrogen	(1·49)	(1·84)	+·35
Equal to ammonia	(1·81)	(2·23)	+·42
Inorganic matters	(91·27)	(78·63)	−12·64
Consisting of :—			
Soluble silica	2·34	·70	−1·64
Oxide of iron	none	2·55	+2·55
Lime	11·48	22·42	+10·94
Magnesia	2·87	1·17	−1·70
Potash	16·92	3·40	−13·52
Chloride of potassium	2·74	none	−2·74
Chloride of sodium	40·35	33·31	−7·04
Phosphoric acid	4·83	·60	−4·23
Sulphuric acid	3·94	2·88	−1·06
Carbonic acid and loss	5·80	11·60	+5·80
	70,000·00	70,000·00	

In the above table the gain is expressed by the sign + ; the loss by −.

The preceding analytical results suggest the following remarks:—

1. It will be noticed that liquid manure in contact with soil parts with a considerable quantity of ammonia, which, in some form or the other, is taken up by the soil. In this experiment soil and liquid manure were employed in the proportion of 2 of soil to 7 of liquid. A gallon of liquid manure in this experiment yielded to 20,000 grains of soil 14·77 grains of ammonia; accordingly, 1000 grains of soil absorbed ·738 grains of ammonia. Whether this is the maximum proportion of ammonia which this soil is capable of absorbing, or whether it would have taken up more or less ammonia when mixed with liquid manure in a different proportion than in the experiment, I am unable to tell for the present. It appears to me, however, probable that the concentration of the liquid in some measure determines the amount of ammonia which is retained by the soil.

Referring to a previous experiment with drainings of dungheaps, I find that 11,000 grains of a similar soil to the one from field No. 19 absorbed only ·365 grains of ammonia, or about half the quantity. These drainings of a dungheap originally contained 19·68 grains of ammonia to the gallon, and after filtration through soil 6·91 grains.

Further experiments with different descriptions of ammoniacal manuring matters and the same kind of soil are necessary before it can be decided whether the quantity of ammonia absorbed by a particular soil is constant, or whether it is influenced by the concentration or chemical composition of the manuring liquids with which the soil is brought into contact.

2. The amount of organic matter in the liquid manure employed in the experiment was less before than after filtration through the soil. Pure distilled water left in contact with arable land, I have shown before, extracts a considerable proportion of organic matter from the latter; and as the liquid manure originally contained but little, it need not cause surprise that it dissolved more when brought into contact with a soil containing a fair proportion of decomposed vegetable remains. The increase in organic matter accounts for the somewhat larger proportion of nitrogen in the organic portion of the filtered liquid.

3. On the other hand, the total quantity of mineral matter in the liquid manure after digestion with the soil has diminished in about the same proportion in which that of organic matter has increased.

4. It is worthy of notice that the liquid manure originally contained no oxide of iron. Left in contact with soil it dissolved 2·55 grains per gallon. The liquid analysed was *perfectly* clear, and the oxide of iron found cannot, therefore, arise from any suspended particles of soil. I have, moreover, repeated the

experiment with the same results, and find in all instances in which I operated with liquid manure upon soils rich in oxide of iron and organic matters, that oxide of iron is dissolved. In other cases no oxide of iron passed into the liquid manure. May not the oxide of iron, dissolved in considerable quantities from some soils through the agency of liquid manure, be injurious to vegetation, and partly account for the failure that is experienced with liquid manure on some soils?

5. Lime, it will be noticed, was rendered soluble by the liquid manure left in contact with soil. An imperial gallon contained nearly 11 grains more after than before filtration. Most of the lime occurred originally in the manure as bi-carbonate, and some only as sulphate. In the same states of combination, no doubt, the greater part of the lime occurs also in the filtered liquid.

Combining the sulphuric acid with lime, and the rest of the lime with carbonic acid, we have in this liquid manure, before and after filtration through soil:—

	Before Filtration.	After Filtration.
Sulphate of lime	6·69	4·89
Bi-carbonate of lime	22·45	50·24

Whilst thus the proportion of sulphate of lime in the filtered liquid is but little diminished, that of bi-carbonate of lime is very much greater than in the original liquid manure.

6. The small proportion of potash left in the manure after contact with soil is particularly interesting, inasmuch as it shows that the soil not only possessed the power of absorbing ammonia, but also potash—a constituent which in an agricultural point of view is of the greatest importance. It appears that potash is retained by the soil even with greater avidity than ammonia.

Besides the potash, which for the greater part exists in the liquid before and after filtration as carbonate of potash, the soil absorbed the whole of the chloride of potassium. 2·74 of chloride of potassium correspond to 1·73 of potash, which quantity added to the 16·92 grains of potash, present chiefly as carbonate of potash, gives 18·65 grains of potash in the gallon, or, expressed as carbonate of potash, 27·25 grains. After contact with soil, the gallon contained 3·40 grains of potash, or 4·99 of carbonate of potash.

15·25 grains of potash, or 22·76 of carbonate of potash, were thus absorbed by 20,000 grains of soil.

1000 grains absorbed ·763 of potash, or 1·138 of carbonate of potash.

7. In a much minor degree than potash the soil absorbed chloride of sodium. By far the larger proportion of common salt remained in the liquid. This result agrees perfectly with previous observations, and with all the experiments noticed in this paper.

The power of soils to absorb potash presents us with a striking contrast to the apparent indifference of soils to absorb soda from its soluble combinations.

8. It is likewise satisfactory to have in this experiment a direct proof of the power of the soil to take up phosphoric acid from soluble combinations with which it is brought in contact. Nearly the whole of the phosphoric acid originally contained in the manure was taken up by the soil. A much larger quantity of phosphoric acid would have been taken up by this soil, if a liquid richer in phosphoric acid had been passed through it. Experiments with soluble phosphates have shown that this is the case. My reason for alluding to this matter here is to guard the reader against the supposition that the quantity of phosphoric acid absorbed by the soil expresses its maximum absorptive power for phosphoric acid. The fact that some phosphoric acid was left in the liquid after 24 hours' contact with soil might readily give rise to such an opinion.

Direct experiments have shown to me that the power of this soil to absorb phosphoric acid is very much greater than appears in this experiment.

Although it is quite true that nearly the whole of the phosphoric acid contained in a liquid is retained by a moderate quantity of soil, it cannot be inferred from this that plants take up phosphoric acid in the shape of an insoluble compound ; for a soil which is capable of absorbing a large quantity of phosphoric acid, when brought in contact with a liquid containing but a small proportion of the amount of phosphoric acid which the soil is capable of retaining, never completely removes the phosphoric acid. A certain quantity remains in solution—a quantity which I believe is sufficient to account for all the phosphoric acid which is found in the ashes of plants.

In all probability it is the function of the soil to transform readily soluble compounds of phosphoric acid into combinations which are so little soluble in water that in common life they pass for insoluble, but which are still sufficiently soluble to supply the growing plant with the necessary amount of this kind of mineral food. This beautiful power of soils effectually prevents the waste which heavy rains infallibly would occasion, and compounds more conducive to the health of plants are formed ; for I believe we have sufficient evidence to show that all very soluble saline matters, however useful or necessary they may be for every kind of agricultural produce, impede the rapid growth of plants when they are presented too abundantly to the roots of plants.

The next experiment was made with a soil from a permanent pasture.

The mechanical analysis of this soil yielded the following results:—

Moisture	2·42
Organic matter	11·70
Lime	1·54
Clay	48·39
Sand	35·95
	100·00

On being submitted to chemical analysis, the following results were obtained:—

Moisture	2·420
Organic matter	11·700
Oxides of iron and alumina	11·860
Carbonate of lime	1·240
Sulphate of lime	·306
Containing sulphuric acid	(·180)
Phosphoric acid	·080
Chloride of sodium	·112
Potash (soluble in acid)	·910
Soluble silica	4·090
Insoluble siliceous matter	67·530
	100·248

The composition of this soil differs materially from that used in the preceding experiment. It is a soil which contains much less lime and a good deal more sand than the soil from the College farm. It belongs to the class of vegetable moulds, is moderately stiff, and bears a good and tolerably abundant herbage.

Soil and liquid manure were mixed as before in the proportion of 2 of soil to 7 of liquid; after 24 hours the clear liquid was poured from the soil; the liquid was then allowed to settle for 6 or 8 days and then filtered. Notwithstanding every care to obtain a perfectly clear liquid, a little finely suspended clay passed through the filter. This clay is mentioned in the subjoined analysis as *insoluble siliceous matter*, and of course does not belong properly to the liquid.

The analysis of the liquid left in contact with the soil was executed exactly in the same manner as that of the liquid in the preceding experiment, and the following results were obtained:—

Composition of the inorganic matter (ash).

Soluble silica	2·73
Insoluble siliceous matter	2·66
Lime	22·51
Magnesia	2·57
Potash	4·64
Chloride of potassium	4·36
Chloride of sodium	35·03
Phosphoric acid	1·56
Sulphuric acid	2·44
Carbonic acid and loss	21·50
	100·00

The fixed residue left on evaporation of the liquid had the following percentage composition:—

Organic matter		21·60
Containing nitrogen		(1·52)
Inorganic matters	78·40	
Consisting of:—		
Soluble silica		2·14
Insoluble siliceous matter		2·08
Lime		17·64
Magnesia		2·01
Potash		3·63
Chloride of potassium		3·41
Chloride of sodium		27·46
Phosphoric acid		1·22
Sulphuric acid		1·91
Carbonic acid and loss		16·90
		100·00

According to these data, the composition of the liquid manure per gallon is as stated in the following table:—

Composition of Liquid Manure, before and after Filtration through Soil from a permanent Pasture.

An imperial gallon contains:—	Before Filtration.	After Filtration.	Gain or loss.
Water and volatile ammonia compounds	69,888·14	69,856·85	−31·29
Containing:—			
Ammonia, as carbonate and humate of ammonia	(35·58)	(20·83)	−14·75
Organic matters	20·59	31·14	+10·55
Containing nitrogen	(1·49)	(2·20)	+·71
Equal to ammonia	(1·81)	(2·67)	+·86
Inorganic matters	(91·27)	(112·01)	+20·74
Consisting of:—			
Soluble silica	2·34	3·06	+·72
Insoluble siliceous matter	..	2·97	+2·97
Lime	11·48	25·21	+13·73
Magnesia	2·87	2·87	..
Potash	16·92	5·19	−11·73
Chloride of potassium	2·74	4·88	+2·14
,, sodium	40·35	39·23	−1·12
Phosphoric acid	4·83	1·74	−3·09
Sulphuric acid	3·94	2·73	−1·21
Carbonic acid and loss	5·80	24·13	+18·33
	70,000·00	70,000·00	

We learn from these results:—

1. That this soil absorbed very nearly the same quantity of ammonia which was absorbed by the soil from the College farm; 20,000 grains in this experiment absorbed 14·75 grains of ammonia, or 1000 grains absorbed ·737 grains.

2. Like the preceding soil the pasture land yielded to liquid manure some additional organic matter. This organic matter likewise contained some nitrogen.

3. The filtered liquid contained nearly 21 grains more of mineral matter than the manure before coming in contact with soil.

4. This increase in mineral matter is chiefly due to carbonate of lime, which is much more abundant in the filtered liquid than in the original liquid manure.

It is chiefly in the state of bi-carbonate that lime occurs in the manure; only a small proportion occurs as sulphate of lime or gypsum.

If the sulphuric acid in these analyses is united with lime to form gypsum, and the rest of the lime calculated as bi-carbonate of lime, there will be in the liquid manure—

	Before Filtration.	After Filtration.
Sulphate of lime	6·69	4·64
Bi-carbonate of lime	22·45	59·91

It will be seen that the proportion of bi-carbonate of lime which passed into the liquid manure is greater than in the preceding experiment, notwithstanding the much larger quantity of carbonate of lime in the Cirencester soil. We have here an indication that the changes which take place when manuring matters are brought into contact with soil are not merely dependent on the percentage composition of the soil, but likewise on the state of combination in which the constituents occur in the soil. A soil containing much less lime may thus yield to a liquid containing a number of organic and inorganic compounds even more lime than another soil three or four times as rich in carbonate of lime.

5. The proportion of chloride of sodium (common salt) in the filtered liquid is nearly as large as in the original liquid.

6. On the other hand the absorption of potash is very marked. Originally the manure contained 16·92 of potash and 2·87 of chloride of potassium per gallon. After having been left in contact with soil it only contained 5·19 grains of potash and 4·88 grains of chloride of potassium. Calculating the potassium in chloride of potassium as potash, and adding it to the rest, we have—

	Grains of Potash.
In manure before filtration	18·65
„ after filtration	8·26
Difference	10·39

20,000 grains of soil in this experiment thus absorbed 10·39 grains of potash, or 1000 grains absorbed ·519 grains of potash.

7. No absorption of chlorine took place in this experiment.

On looking at the composition of the soil used in this experiment, it will be noticed that pure water extracts from it more chloride of sodium than is usual in the case of other soils.

This circumstance no doubt fully explains the fact that the liquid manure, after passing through the soil, contained even a little more chlorine than before.

The amount of chlorine in the chloride of potassium and chloride of sodium found in a gallon of liquid before filtration is 25·78 grains.

After filtration through soil we have 26·12 of chlorine in the liquid, thus showing that no chlorine whatever was abstracted from the liquid by the soil.

8. Most of the phosphoric acid was taken up by this soil, but not so completely as by the Cirencester soil. However, the quantity of phosphoric acid left in the liquid after having remained in contact with the soil from a permanent pasture, is very trifling. We have here a proof, that soluble phosphates in passing even through soils poor in lime are rendered comparatively speaking insoluble.

On the whole, then, we find that this pasture-land, like the soil used in the preceding experiment, possesses in a high degree the power of absorbing from liquid manure, ammonia, potash, and phosphoric acid, and yielding to the liquid, lime, organic matters, and small quantities of other less important constituents. In other words, all the more valuable fertilizing ingredients of liquid manure were absorbed by the soil, or at all events brought into states of combination in which they are little soluble in water.

Having ascertained in previous trials that the power of different soils to absorb manuring matters varies greatly, I was anxious to institute an experiment with the same description of liquid manure and a very poor soil. I therefore selected a soil from the neighbourhood of Cirencester, which soil, although it occurs in the midst of the oolite formation, is greatly deficient in lime, and contains sand in great excess. The mechanical analysis of this soil gave the following results:—

Organic matter	5·36
Clay	4·57
Lime	·25
Sand	89·82
	100·00

Thus 9-10ths of the soil consisted of sand, about 1-20th part only was clay, and 1-20th part organic matter.

On being submitted to a detailed chemical analysis, 100 parts were found to contain, when dried at 212° Fahr.,—

Organic matter and a little water of combination ..	5·36
Oxides of iron and alumina	5·70
Carbonate of lime	·25
Alkalies and magnesia	·49
Phosphoric acid	a mere trace.
Sulphuric acid	·08
Soluble silica	1·01
Insoluble siliceous matter (sand)	87·11
	100·00

We have here a soil which hardly contains any lime, and such minute traces of phosphoric acid, that this constituent could not be determined quantitatively.

The sand obtained by washing had a deep red colour, and contained a good deal of oxide of iron.

The composition of this soil fully explains the extremely infertile character of the land, and its avidity to swallow up manure without exhibiting any corresponding effect on the produce.

A portion of the soil, sufficient for the purpose of ascertaining the changes which liquid manure undergoes in contact with the soil, was mixed with this liquid, and the experiment carried out in all particulars precisely in the same manner as in the two preceding cases.

The following results were obtained:—

General composition of Liquid Manure left in contact for 24 hours with Sandy Soil.

1 imperial gallon contained:—

		Grains.
*Water and volatile ammonia compounds		69,892·41
†Organic matters	25·06	107·59
Inorganic matters (ash)	82·53	
		70,000·00

* Containing ammonia	33 15
† Containing nitrogen	1·40
Equal to ammonia	1·70

The mineral portion, or the ash of filtered liquid manure contained in 100 parts—

Soluble silica	6·19
Insoluble siliceous matter	1·69
Oxide of iron	2·52
Lime	9·73
Magnesia	·90
Potash	14·55
Soda	·55
Chloride of sodium	47·56
Phosphoric acid	2·33
Sulphuric acid	4·45
Carbonic acid and loss	9·53
	100·00

The total dry residue left on evaporation of the filtered liquid, amounting to 107·59 grains per gallon, had the following percentage composition:—

Organic matter		23·28
Containing nitrogen		(1·30)
Mineral matter	76·72	
Consisting of:—		
Soluble silica		4·75
Insoluble siliceous matter (a little fine clay passed through filter)		1·29
Oxide of iron		1·93
Lime		7·56
Magnesia		·70
Potash		11·16
Soda		·42
Chloride of sodium		36·48
Phosphoric acid		1·78
Sulphuric acid		3·41
Carbonic acid and loss		7·24
		100·00

According to these and other details previously mentioned, the composition of liquid manure before and after contact with this soil, and the loss and gain, is given in the following table:—

Composition of Liquid Manure before and after contact with a Sandy, very infertile Soil, from the neighbourhood of Cirencester, and Loss or Gain in Constituents.

An imperial gallon contains:—	Before Filtration.	After Filtration.	Loss.	Gain.
Water and volatile ammonia compounds	69,888·14	69,892·41	..	+42·7
Containing:—				
Ammonia, as carbonate and humate of ammonia	(35·58)	(33·15)	−2·43	..
Organic matter	20·59	25·06	..	+4·47
Containing nitrogen	(1·49)	(1·40)	−·09	..
Equal to ammonia	(1·81)	(1·70)	−·11	..
Inorganic matters	(91·27)	(82·53)	−8·74	..
Consisting of:—				
Soluble silica	2·34	5·10	..	+2·76
Insoluble siliceous matter (fine clay)	..	1·39	..	+1·39
Oxide of iron	..	2·07	..	+2·07
Lime	11·48	8·03	−3·35	..
Magnesia	2·87	·74	−2·13	..
Potash	16·92	12·01	−4·91	..
Chloride of potassium	2·74	none	−2·74	..
Soda	..	·45	..	+·45
,, sodium	40·35	39·25	−1·10	..
Phosphoric acid	4·83	1·92	−2·91	..
Sulphuric acid	3·94	3·67	−·27	..
Carbonic acid and loss	5·80	7·90	..	+2·10
	70,000·00	70,000·00		

Noticing the chief points of interest that attach to these results, I would direct attention to the following particulars :—

1. It will be seen that this sandy soil possessed in a very weak degree the power of absorbing ammonia from liquids. Thus, 1 gallon of liquid, after having remained in contact with soil for 24 hours, only contained 2·43 grains less ; or, in round numbers $2\frac{1}{5}$ grains less of ammonia. This small quantity, it will be remembered, is removed by 20,000 grains of soil ; 1000 grains consequently absorbed only ·121 of a grain of ammonia. In this particular this soil offers a striking contrast to the soils used in the preceding experiments, which absorbed about 6 times as much ammonia.

2. The proportion of organic matter in the filtered liquid is a little larger than in the original liquid ; but no appreciable difference exists in the amount of nitrogen in the organic matter before and after filtration through the soil.

3. In passing through the red-coloured sandy soil, the liquid manure took up an appreciable quantity of oxide of iron. In all probability the oxide of iron was united with an organic acid, or with organic matters similar in character to the organic matters found in bog-iron ore.

4. The soil used in this experiment, it will be remembered, contains a good deal of soluble silica. Liquid manure in contact with it appears to dissolve an appreciable quantity of soluble silica.

5. In the two preceding experiments we have seen that liquid manure kept in contact with soil becomes much richer in lime. But in the case of the sandy soils, instead of lime being taken up by the liquid manure, a considerable quantity of the carbonate of lime contained in the liquid used in the experiment was actually removed by the soil. The amount of lime in this soil is evidently insufficient to supply the wants of the crops we cultivate on the farm ; it is therefore fortunate that a soil thus constituted possesses the power of depriving manuring mixtures of those constituents which are required in considerable quantities for sustaining a healthy growth of plants. This property of soils to store up food for plants is not confined to one particular kind of fertilizing matter, but it applies to them all, and manifests itself in different ways. In most cases special power exists in soils to remove ammonia, potash, and phosphoric acid from liquid fertilizers brought in contact with them ; and less important and more abundant materials pass into the liquid that drains from soils. But this order is reversed if liquid fertilizers act upon such soils as the one used in the experiment before us. Here lime, a cheap and usually abundant ingredient of soils, is actually

absorbed from liquid manure, and retained in a soil which is peculiarly deficient in lime. Experience has shown, moreover, that sandy soil is more benefited by lime and calcareous mixtures than by any other description of manure.

6. On comparing the amount of potash contained in the liquid after filtration through this sandy soil, with the quantity of potash found in the liquid manure after contact with the two preceding soils, a marked difference will be observed. Indeed, the proportion of potash taken up by the sandy soil is quite inconsiderable. We have in this result an indication that soils which do not manifest a high power of absorbing ammonia, likewise have not much effect upon soluble compounds of potash.

7. Still smaller is the power of this soil to absorb soda-salts and sulphuric acid. As regards the compounds of soda, more especially chloride of sodium, the results obtained here agree with the rest. In all the experiments which I have hitherto made, either with highly complex fertilizing mixtures, or with simple salts of soda, I find that soda generally passes through the soil unabsorbed.

8. Again, it may be noticed, that we have here an instance of phosphoric acid becoming absorbed from its soluble combinations by a purely sandy soil, in which lime is almost altogether absent. At the same time it will be seen that phosphoric acid is not so completely removed by such a soil, as by stiffer and more calcareous soils.

On the whole, these experiments afford a ready explanation of the fact that the effects of manure on proverbially hungry soils are very transient.

They suggest, likewise, that the observed failure of superphosphate as a turnip-manure on such land may be due in some measure to the facility with which soluble phosphates are washed out of the soil.

The fourth experiment with the same liquid manure was tried on a soil of moderately retentive and naturally very fertile properties.

The mechanical analysis of this soil and its subsoil gave :—

	Surface-soil.	Subsoil.
Sand	76·16	55·15
Clay	18·09	41·79
Lime, magnesia, &c.	1·37	·47
Organic matter	4·38	2·59
	100·00	100·00

Submitted to detailed chemical analysis, the soil and subsoil were found to contain in 100 parts :—

	Surface-soil.	Subsoil.
Organic matter and water of combination ..	4·38	2·59
Alumina	2·15	5·39
Oxide of iron	3·15	7·16
Lime	·77	·26
Magnesia	·13	1·22
Potash	·49	·88
Soda	·13	·28
Phosphoric acid	·12	·19
Chlorine	trace	trace
Sulphuric acid	·06	·02
Carbonic acid	·31	1·79
Insoluble silicates and sand	88·31	80·24
Consisting of :—		
Silicic acid	85·11	62·61
Alumina	2·36	14·55
Lime	..	·85
Magnesia	·50	·23
Potash	·25	1·77
Soda	·09	·21
	100·00	100·00
Containing nitrogen	·182	·09
Equal to ammonia	·220	·11

Both the subsoil and surface soil were of a red colour. The surface soil is a friable sandy loam ; the subsoil is stiffer, contains less sand, and more clay.

Equal parts of soil and subsoil were employed in the experiment, and the liquid manure added to this mixed soil in the proportion of 7 of liquid to 2 of soil, as before. The liquid was left in contact with the soil for 3 days, and then filtered and treated in the same manner as the rest of the experiments.

General Composition of Liquid Manure left in contact with a fertile, friable, loamy Soil for three days.

An imperial gallon contains :—

*Water and volatile ammonia compounds ..		69,871·03
†Organic matter	35·52	128·97
Mineral matters	93·45	
		70,000·00
*Containing ammonia		25·84
†Containing nitrogen		·84
Equal to ammonia		1·02

The analysis of the mineral matters gave the following results :—

Soluble silica	2·39
Insoluble siliceous matter (suspended clay) ..	4·69
Lime	17·66
Magnesia	2·54
Potash	11·73
Chloride of potassium	5·66
Chloride of sodium	41·85
Phosphoric acid	1·57
Sulphuric acid	5·51
Carbonic acid and loss	6·40
	100·00

The solid matter, amounting to 128·97 grains to the gallon, had the following percentage composition :—

Organic matters		27·54
Containing nitrogen		(·65)
Mineral matters	72·46	
Consisting of :—		
Soluble silica		1·73
Insoluble siliceous matter (suspended clay)		3·40
Lime		12·79
Magnesia		1·84
Potash		8·50
Chloride of potassium		4·10
Chloride of sodium		30·32
Phosphoric acid		1·14
Sulphuric acid		3·99
Carbonic acid and loss		4·65
		100·00

According to these and previous results obtained in the analysis of the original liquid manure, we find in an imperial gallon of liquid manure before and after having remained in contact with soil for 3 days, the constituents mentioned in the subjoined Table :—

Composition of Liquid Manure before and after contact with a red-coloured, friable, loamy, fertile Soil and Clay Subsoil, and Loss or Gain in Constituents.

An imperial gallon contains :—	Before Filtration. grains.	After Filtration. grains.	Loss.	Gain.
Water and volatile ammonia compounds	69,888·14	69,871·03	−17·11	..
Containing :—				
Ammonia, as carbonate and humate of ammonia	(35·58)	(25·84)	−9·74	..
Organic matter	20·59	35·52	..	+14·93
Containing nitrogen	(1·49)	(·84)	−·65	..
Equal to ammonia	(1·81)	(1·02)	−·79	..
Inorganic matters	(91·27)	(93·45)	..	+2·18
Consisting of :—				
Soluble silica	2·34	2·23	−·11	..
Insoluble siliceous matter (suspended clay)	..	4·38	..	+4·38
Lime	11 48	16·50	..	+5·02
Magnesia	2·87	2·37	−·50	..
Potash	16·92	10·96	−5·96	..
Chloride of potassium	2·74	5·29	..	+2·55
„ sodium	40·35	39·11	−1·24	..
Phosphoric acid	4·83	1·45	−3·38	..
Sulphuric acid	3·94	5·18	..	+1·24
Carbonic acid and loss	5·80	5·98	..	+·18
	70,000·00	70,000·00		

The changes which took place in the chemical constitution of the liquid manure in contact with this soil are similar to those noticed in the first and second experiment. It will be seen, however, that the power of this loamy soil to absorb ammonia and potash is not equal to that exhibited by the pasture land and by the calcareous clay from Cirencester. Thus, in the experiment before us, 20,000 grains of loamy fertile soil absorbed 9·74 grains of ammonia; or 1000 grains absorbed ·487; whilst 1000 grains of Cirencester soil absorbed ·738 of ammonia, and 1000 grains of pasture land, ·737.

We also find a smaller proportion of potash retained by the loamy soil than by the Cirencester soil and by the pasture land. It thus seems probable that soils which absorb much ammonia also absorb much potash.

Again, we find that some lime, though sparingly present in the soil, is taken up by the liquid manure; and that nearly the total amount of chloride of sodium of the original liquid passes unaltered into the liquid which was left in contact with this soil for three days. Other minor changes may be passed over unnoticed, as they agree with previous results on which some observations have been made already.

It will be noticed that none of the four soils used in these experiments had the power of absorbing completely the whole of the ammonia, potash, or phosphoric acid contained in the liquid manure. A certain amount of these constituents always remained in the liquid which was left in contact with soil. As the liquid manure contained a good deal of ammonia and potash, it may be urged that the quantity of soil employed in the experiments in relation to that of the liquid was insufficient for the purpose of complete absorption. But this argument certainly does not hold good in the case of phosphoric acid, and probably not in the case of ammonia or potash. With respect to phosphoric acid, I can speak positively on the subject, for I have filtered through the same soils a very much larger proportion of phosphoric acid, and found that nearly the whole of it was retained by three of the soils. But whether a solution containing much or little phosphoric acid be filtered through a moderately stiff soil, invariably some phosphoric acid passes into the filtered liquid. Again, if a dilute solution of a soluble phosphate is passed through a soil, it may be ascertained readily that there is phosphoric acid in the filtered liquid. If now a fresh quantity of a solution containing phosphoric acid be shaken with the soil through which the first solution has passed, it will be found that the soil takes up a fresh quantity of phosphoric acid. This circumstance appears to me to prove decidedly that soils have not the power of rendering soluble phosphates so completely insoluble that these compounds cannot enter

into the vegetable organism in a soluble state. I believe that the quantity of water which passes into the plant is amply sufficient to dissolve from the soil a sufficient quantity of the various mineral matters required to meet the wants of cultivated plants. In accounting, therefore, for the presence of potash, phosphoric acid, &c., in plants, it cannot be reasonably urged that soluble manuring matters, such as potash, phosphoric acid, &c., in contact with soil, are rendered insoluble, and that therefore plants must take up their food in a solid state. It is true, that the most soluble, and, I may add, the most valuable substances, contained in fertilizing liqnids are rendered *comparatively* insoluble in contact with most soils; but I feel assured that it is impossible to render them *perfectly* insoluble.

All good soils left in contact for a short time with pure rainwater yield a considerable quantity of potash, phosphoric acid, &c., to the water; and water charged with carbonic acid dissolves a still larger proportion of these and other soil-constituents. Purely sandy soils alter (comparatively) but little the composition of liquid fertilisers which are passed through them; clay soils, on the other hand, materially alter the chemical constitution of this liquid. If there is truth in the remarks I have made respecting the solubility of mineral food of plants, and the improbability of plants taking up food in a solid form, we may expect that no soil, however stiff it may be, will completely remove all the ammonia, potash, phosphoric acid, &c., contained in dilute fertilizing liquids. On the other hand, if plants can take up solid food in some mysterious unexplained manner, it would not be surprising that clay soils rendered insoluble the whole of the ammonia, potash, &c., contained in a fertilizing liquid: for, supposing this to be the case, the plant might still grow luxuriantly. The changes which manuring liquids undergo in contact with soil, it will be perceived, have a much wider application than may appear at first sight; they are, indeed, intimately connected with the theory of vegetable nutrition. I am happy, therefore, to be able to report a fifth experiment, which is of peculiar interest in this respect. The experiment was made with a soil from Tiptree Hall, kindly sent to me by Mr. Mechi. This soil, and the subsoil on which it rests, yielded, on mechanical analysis:—

	Subsoil.	Surface-soil.
Moisture	9·46	3·91
Organic matter and water of combination ..	4·87	4·80
Sand	9·26	10·97
Lime	1·12	2·19
Clay	75·29	78·13
	100·00	100·00

Both the soil and subsoil, it will be seen, contain a large preponderance of clay; they are both very stiff, but when improved, I am informed, are very productive. The chemical analyses of these soils furnished the following results:—

	Subsoil.	Surface-soil.
Moisture	9·46	3·91
Organic matter and water of combination	4·87	4·80
Oxides of iron and alumina	17·38	7·85
Phosphoric acid	·06	·04
Carbonate of lime	1·02	2·08
Sulphate of lime	·13	·15
Magnesia	·92	·32
Alkalies and loss	·45	
Insoluble siliceous matter (chiefly clay)	65·71	80·85
	100·00	100·00

The surface soil exhibited bits of chalk, flint, and burnt clay; it had evidently been dressed with burnt clay at some time or other. Equal parts of surface and subsoil were mixed with liquid manure from Tiptree Hall Farm; soil and liquid were repeatedly agitated and then left to settle for three days, after that period the clear liquid was drawn off and analyzed as before. The filtered liquid manure had the following general composition per gallon:—

*Water and volatile ammonia compounds		69,954·92
†Organic matters	5·46	45·08
Mineral matters	39·62	
		70,000·00

*Containing ammonia	1·55
†Containing nitrogen	2·02
Equal to ammonia	·24

The residue which was left on evaporation to dryness, on analysis was found to contain in 100 parts:—

Organic matter		12·11
Containing nitrogen		(·44)
Mineral matters	87·89	
Consisting of:—		
Soluble silica		3·57
Insoluble siliceous matter (suspended clay)		3·57
Oxide of iron		·71
Lime		17·30
Magnesia		6·27
Potash		8·65
Soda		1·16
Chloride of sodium		20·24
Phosphoric acid		4·99
Sulphuric acid		12·40
Carbonic acid and loss		9·03
		100·00

The mineral portion of the residue contained in 100 parts:—

Soluble silica	4·07
Insoluble siliceous matter (suspended clay)	4·06
Oxide of iron	·81
Lime	19·69
Magnesia	7·25
Potash	9·85
Soda	1·33
Chloride of sodium	23·04
Phosphoric acid	5·68
Sulphuric acid	14·11
Carbonic acid and loss	10·11
	100·00

The next table expresses the composition of the liquid manure from Tiptree Hall Farm, in its natural condition and after having remained in contact with soil and subsoil, from a field of the farm at Tiptree Hall.

Composition of Liquid Manure from Tiptree Hall, before and after contact with very stiff Clay Soil and Subsoil from Tiptree Hall Farm, and Loss or Gain in Constituents.

An imperial gallon contains:—	Before Filtration. Grains.	After Filtration. Grains.	Loss. Grains.	Gain. Grains.
*Water and volatile ammonia compounds	69,970·81	69,954·92	−15·89	
†Organic matters	7·70	5·46	−2·24	
Mineral matters	21·49	39·62	..	+18·13
Consisting of:—				
Soluble silica	1·68	1·61	−·07	
Insoluble siliceous matter (fine clay)	·76	1·92	..	+1·16
Lime	4·43	7·80	..	+3·37
Magnesia	1·78	2·87	..	+1·09
Potash	1·31	3·90	..	+2·59
Soda	..	·52	..	+·52
Chloride of potassium	1·10	none	−1·10	
,, sodium	5·46	9·12	..	+3·66
Phosphoric acid	2·36	2·23	−·13	
Sulphuric acid	2·15	5·59	..	+3·44
Carbonic acid and loss	·45	4·06	..	+3·61
	70,000·00	70,000·00		
*Containing ammonia	3·36	1·55	−1·81	
†Containing nitrogen	·52	·202	−·318	
Equal to ammonia	·63	·24	−·39	

In comparison with the liquid manure used in the four preceding experiments, the Tiptree Hall liquid is very weak. It contains scarcely 30 grains of solid matter in the imperial gallon, and only $3\frac{1}{3}$ grains of ammonia. The soil, on the other hand, contains clay in large preponderance, an appreciable quantity of lime, and but little sand: it is, in fact, a very stiff soil. According

to all previous experience, such a soil possesses in an eminent degree the power of absorbing manuring matters; it might be therefore expected that the *whole* of the ammonia contained in such a weak solution as the Tiptree liquid manure would be removed by such a soil when used in the proportion of 2 of soil to 7 of liquid. The same might be suspected with regard to potash and phosphoric acid. However, this experiment shows that a soil distinguished for its great power of absorbing soluble fertilizing matters does not entirely remove them even from a very dilute solution. As the subject is of considerable scientific interest, I may be allowed to examine the results obtained in this experiment a little more in detail, and therefore notice:—

1. Although only 7·7 grains of organic matter were present in the Tiptree liquid manure, Mr. Mechi's soil removed only $2\frac{1}{4}$ in round numbers, leaving $5\frac{1}{2}$ dissolved in the liquid.

2. In the preceding experiments—

1000 grs. of soils from	College Farm absorbed ..	·738	of ammonia.
,,	pasture land	·737	,,
,,	sterile sandy land	·121	,,
,,	fertile loamy land ..	·487	,,

None of these soils contained so much clay as Mr. Mechi's soil, but, nevertheless, they all absorbed more ammonia than the stiff clay soil in the experiment with a very dilute liquid. There are only 3·36 grains of ammonia in a gallon of the Tiptree liquid manure, which certainly might be expected to be absorbed by 20,000 grains of soil; for, if so, 1000 grains would only have absorbed ·168 of a grain of ammonia. Nearly the same quantity of ammonia, we have seen, was absorbed by a soil consisting almost entirely of sand, which, we know, does not possess in a high degree the power of retaining ammonia. Notwithstanding the large proportion of clay and the small qnantity of ammonia in the liquid manure from Tiptree Hall Farm, only 1·81 grains of ammonia were absorbed by 20,000 grains of soil, and 1·55 grains remained in the liquid after three days' contact with it. 1000 grains of this soil thus absorbed only ·0905 of a grain of ammonia.

There can be no doubt that a stronger solution of ammonia passed through Mr. Mechi's soil would have parted with a much larger proportion of ammonia than in the present experiment. A distinct proof, then, is here afforded that soluble manuring matters—like ammoniacal salts in contact with soil—are not rendered entirely insoluble. In this experiment we have the most favourable condition for the complete absorption of ammonia, yet nearly one-half of the ammonia is left in the liquid after contact with the soil: thus showing plainly that the compounds which we cannot doubt are formed in clay soils, when soluble

compounds of ammonia are brought in contact with them, are still to some extent soluble in water. This fact explains likewise the different results which are obtained in ascertaining the absorptive properties of soils for ammonia when limited quantities of strong or very dilute solutions of ammonia are employed in such experiments. If, therefore, 1000 grains of soil absorb in one particular experiment say ·55 of a grain of ammonia, it does not follow that this quantity expresses the maximum proportion of ammonia which that soil is capable of taking up.

3. In conformity with other experiments, a larger proportion of lime was found in the filtered liquid manure than in the liquid before coming in contact with the soil.

4. The proportion of magnesia and sulphuric acid in the filtered liquid likewise is larger than in the original manure.

4. It will be noticed that the amount of potash and chloride of potassium in the Tiptree liquid manure is very small. Instead of diminishing, when brought into contact with soil, as in all the other experiments, the amount of potash in a gallon of the liquid manure left in contact with soil for three days was larger than in the liquid before coming in contact with the soil. It thus appears that the soil contained, like most clay soils, abundance of alkaline silicates, which yielded to liquid manure a certain small amount of potash and also of soda, in addition to the alkalies naturally contained in the manure.

5. In conclusion, I would notice that the proportion of phosphoric acid in the liquid manure, after contact with this soil, is very nearly the same as that contained in the original liquid. Scarcely any absorption of phosphoric acid thus took place, or, perhaps, more correctly speaking, the compounds of phosphoric acid which are formed in the soil are so inconsiderable in amount that there is sufficient water in a gallon of liquid to keep them nearly entirely in solution.

Conclusions.

With a view of saving trouble to readers who are not disposed to go through all the chemical evidence contained in the preceding pages, I briefly notice in conclusion the chief points of interest which may be gathered from this account of my experiments.

1. Liquid manure, in contact with soil, undergoes a number of chemical changes.

2. These changes are greater in the case of clay and calcareous soils than in the case of sandy soils.

3. Passed through clay, loamy, and calcareous soils, liquid manure leaves a considerable quantity of ammonia in the soil.

4. Under the same circumstances, liquid manure parts likewise with potash and phosphoric acid.

5. Sandy soils remove from liquid manure but little ammonia and likewise not much potash.

6. With the exception of purely sandy soils, liquid manure, as used in practice, leaves the greater portion of all the most valuable fertilizing matters in the generality of soils.

7. The comparative power of different soils to remove ammonia, potash, and phosphoric acid from liquid manure differs greatly.

8. Liquid manure passed through sandy soils rich in soluble silica takes up soluble silica.

9. Soils that absorbed much ammonia also absorbed much potash, and the soils which absorbed little ammonia also absorbed little potash.

10. Soda-salts (common salt) are either not at all removed from liquid manure or only to a small extent.

11. Chlorine, and generally sulphuric acid, remain unaltered in quantity in liquid manure passed through different soils.

12. In most cases, liquid manure left in contact with different soils becomes richer in lime.

13. The proportion of lime which liquid manure takes up from the soils with which it is brought in contact does not altogether correspond with the relative proportions of lime in the different soils.

14. Liquid manure, passed through a sandy soil greatly deficient in lime, became poorer in lime: thus showing that the property of soils of storing up food for plants is not confined to ammonia, potash, or phosphoric acid; but that it is a property which manifests itself in a variety of ways. Thus, soils rich in lime yield this substance to liquid manure; soils in which lime is deficient may abstract it from liquid manure. Again, potash usually is removed from liquid manure left in contact with soil; but, in particular cases, liquid manure may even become richer in potash after filtration through soil.

15. Very soluble saline fertilizing compounds are probably injurious to vegetation when supplied too abundantly to the land.

16. All moderately fertile soils have the power of rendering the more important soluble fertilizing matters much less soluble; but in none of the experiments were ammonia, potash, phosphoric acid, and other compounds that enter into the composition of the ashes of our cultivated crops, rendered perfectly insoluble.

17. It does not appear probable that plants take up mineral food from the soil in the shape of totally insoluble combinations.

Royal Agricultural College, Cirencester.

XII.—*On the Influence of Climate on Cultivation.* By R. Russell, F.R.S.E.

This subject has already been somewhat generally discussed in the pages of this Journal in two valuable papers. In its elucidation very elaborate series of meteorological figures have been collected and applied in explaining the more obvious features and influences of climate within the British Islands. To repeat these figures would be out of place, and we are desirous to take up ground which has not been already occupied. In treating the subject, we shall divest it, in the first place, of all technicalities or reference to meteorological figures. On a future occasion we may take up this particular branch of the subject with the view of simplifying and bringing out more graphically the variations of temperature and humidity. Indeed, we are of opinion that the ordinary methods of instrumental expression of those elements which constitute the peculiarities of climate are anything but satisfactory.

At present, however, it is our object to deal with those branches of the subject which are strictly practical: to state as concisely as possible the influence of climate on the growth of those plants that are principally cultivated; to trace the varieties in the agricultural practices of different localities, induced by differences in their climatic conditions; to point out the varieties in rotations, cultivation, and manuring of crops, which certain climatic conditions favour.

It should be kept in view that other elements often override those of climate, and are chiefly concerned in forming our agricultural systems. Thus, in all parts of Britain, the demand for particular crops, with unlimited supplies of manure, render farming much alike in the neighbourhood of large towns. It is in inland districts where the features of distinct systems stand out in boldest relief. There we generally find that those crops are most cultivated which are most suitable to the soil and climate. Yet to this rule there are many exceptions, owing to what may be termed the practical economy of cropping. Thus turnips are well known to thrive best in the cooler and moister parts of the British Islands. The climate is far more suitable for turnips in Scotland and the West of England than in Norfolk. It has often appeared to many a curious circumstance, that turnip culture should have begun in the eastern counties and extended to the north and west. In no part of Scotland is a fourth part of the arable land devoted to the culture of turnips, as is the case in Norfolk. In the West of England and Ireland this crop is only slowly making its way, as the pioneer of better cultivation. It is

an expensive crop to raise, and, when done so to such an extent as a fourth of the arable land, it demands a correspondingly larger breadth of the higher priced grains. This is a resource which neither the Scotch nor the West of England farmer can fall back upon. Literally speaking, they cannot afford to grow so large a breadth of turnips as the Norfolk farmer, in consequence of not being able to grow so large a breadth of barley and wheat, which are the most valuable grain crops. Other compensations, however, intervene, and enable the Scotch farmer to pay as high a rent for land of equal fertility as the Norfolk farmer can do.

Chemistry teaches us the changes which matter undergoes in passing from the inorganic to the organic kingdom; the laws of physiology, the functions of the various organs, as well as the nature and uses of the products that are formed; the laws of climate, the conditions under which the different kinds of plants flourish or produce their various products in greatest abundance and perfection.

Other things being equal, the force and rapidity of vegetable growth is in proportion to the temperature of the atmosphere and soil. It is well known that plants grow with greater vigour in summer than in spring—in tropical countries than in temperate. The higher temperature enables plants to digest or assimilate a larger quantity of food in a given time. Plants are therefore far more grateful for a supply of manure when applied for summer than for spring growth. The vegetables raised by the market-gardener are said to be "forced by manure," because the common kinds are grown during the colder period of the year.

But not only have plants the power of digesting a larger quantity of manure during the warmer season, but they seem also to have much greater powers of absorbing food from the atmosphere. This may arise from two causes. First, it is highly probable that ammonia, a most active agent in producing vegetable growth, exists in greater abundance during the warmer season—its quantity in the atmosphere being to some extent regulated by that of its water or vapour, which is always greatest in summer. The second cause of the greater powers possessed by plants of absorbing ammonia during the warmer season is perhaps the increased vigour of the plants.

When manure is abundant, the agriculturist endeavours to select those plants which are capable of expanding in size in proportion to the liberality of the treatment. This can only be fully accomplished when their period of growth extends over the warmer season. These conditions are fulfilled in the meadow under irrigation, or in a field of cabbages; both grow so long as the temperature is sufficient for vegetable growth, and both possess great capacities of growth under liberal treatment.

The amount of food which plants can derive from the atmosphere appears to be regulated by principles which are not very dissimilar from those which hold with respect to the capacities of plants for manure. The capabilities of plants for absorbing food from the atmosphere depend upon the extent of surface of healthy succulent leaf which they can maintain during the season of growth. Under favourable circumstances, grass and clover send forth a perpetual succession of leaves, which renders them much less dependent on a supply of food to their roots than the wheat plant. Or in the case of the natural vegetation of forests, which yearly produces a great amount of organic matter, through the large surface of leaf exposed during the warm season.

The suitability of climate for forage crops consists in its capability of maintaining them in health throughout the growing season. Within certain limits, the strength of vegetation depends upon temperature, if a due supply of moisture exists. When moisture is deficient, assimilation is retarded or prevented, and the most abundant supplies of food are of little avail in promoting growth. Much of the skill of the agriculturist consists in selecting those plants which are best adapted to the climate, as well as in adopting those particular acts of cultivation that serve to compensate for deficiencies of climate.

One of the principal properties that render soils fertile is their power of absorbing and retaining moisture, and thus furnishing a steady supply to the plants that grow upon it. One, also, of the chief objects of cultivation is to increase this power, and by this means increase their productiveness. As we shall have occasion to point out, climate greatly influences the maxims that guide agriculturists in this matter.

The physical or mechanical properties of soils are chiefly concerned in the distribution of the natural vegetation, such as trees and grass. Blowing sands on the sea-coast are tenanted by those species of grasses that can resist the extreme aridity of the medium in which their roots are fixed. It is only on deep loams that the finer and more luxuriant grasses flourish in dry climates. These can sustain growth during the heats and droughts of summer: except by the operations of drainage and marling, art can do little to increase the absorbent powers of a field under grass. Deep-rooting plants, such as clover, sanfoin, and lucerne, are less under the influence of drought, and are consequently greater objects of culture in dry climates. On the other hand, the humid climate of the West of England renders it particularly genial to the growth of the shallow-rooted grasses, which become an economical means of restoring fertility to land exhausted by cropping.

The influence of climate on the growth of the common perennial

rye-grass may be said to cause one of the peculiar differences between the rotation of Norfolk and that of the north and west of the island. This is a valuable pasture plant in Scotland and the West of England. In these parts the climate promotes its continuous growth throughout the summer. As it is cropped it tillers freely, sending out fresh stems and roots, and occupying the land to the exclusion of weeds of all kinds. It stores up within the soil organic matter, which yields on decomposition abundant food for other plants.

Pasturing seeds for two years is very generally regarded as a safe and sound system of maintaining fertility in Scotland and the West of England. Such a practice is usually prescribed in leases as well calculated to fertilize the soil and husband its resources: of course this is only done to advantage on easy loams which maintain grasses in a growing state. Tenacious soils seldom support good grasses a second year, and then only when the indigenous kinds come up; for they seem to be unfitted for rye-grass in consequence of the treading of the ground by cattle or sheep being inimical to the healthy functions of the roots. Pasturing seeds for two years may be regarded, in a lesser degree certainly, as improving soils in the same manner as consuming on the land a crop of turnips for two years in succession. The economical advantage of pasture being that it involves no expense in manure and cultivation.

Rye-grass is an inferior plant in all the drier districts of England: being a shallow-rooted plant it is ill-provided for maintaining itself in vigour during the heats of the summer months. Clovers or other plants with deep roots have an immense advantage over it in producing forage; but the want of good artificial grass to take full possession of the surface soil in Norfolk, and maintain its growth in summer, allows other useless and unprofitable plants to spring up. Instead of the land improving in fertility by two years' pasture it becomes filled with weeds as the clovers thin out; this, it appears to us, is the principal reason why the four-course shift has been so long followed in Norfolk, and the five-course in the West of England and Scotland. This forms a dividing ridge between the two systems; and the spirit of each, as exhibited in other farm practices, pursues somewhat opposite courses—which it is our object to trace.

The four-course shift is necessarily much more expensive than the five-course. Though the climate of Norfolk is inferior to that of the north or the west for turnips—the most expensive crop that is cultivated, still a fourth must be given; another fourth must be sown out annually with seeds; one-half of the land also is annually under the exhausting influence of white crops: all which involves not only great expense in cultivation, but in manuring.

Under the five-course the expense of culture is less; and being more self-sustaining by pasturing seeds two years, it costs less for manure. The truth is, neither the Welch nor the Scotch farmer can well afford to grow so great a proportion of turnips as the Norfolk farmer does. Wheat cannot be sown with advantage after seeds in moist climates; it is difficult to obtain a large breadth of this crop after turnips: inferior priced grains must therefore be resorted to. A smaller gross produce is obtained at less expense. That this must be so will be rendered sufficiently apparent in looking at the aggregate sum which is likely to be derived from the produce of the grain crops in the course of a twenty years' lease under the four and five course shifts. During that period, on a farm of 200 arable acres, the Norfolk farmer would raise—

1000 acres of wheat, say 4 quarters an acre, 4000 quarters at 50*s*. ..	10,000
1000 acres of barley, say 5 „ „ 5000 „ at 30*s*. ..	7,500
Being a total for grain crops of	£17,500

In Scotland and the West of England, oats must succeed the grass, and wheat and barley the turnips. In a twenty years' lease of a farm of 200 acres, under the five-course shift, there would be raised—

800 acres of oats at 6 quarters, 4800 quarters at 25*s*.	6,000
400 „ barley at 5 „ 2000 „ at 30*s*.	3,000
400 „ wheat at 4 „ 1600 „ at 50*s*.	4,000
	£13,000

If we assume that the value of the land is the same in both cases, it is evident that the same rents can only be paid by the Scotch farmer by the inferior crops involving less expense in cultivation. So long as he only raises the common grain crops he cannot afford to farm so high as the English farmer, seeing that the limits of production are sooner attained. The English farmer finds it profitable to consume large quantities of cake and inferior grain in the feeding of stock for the purpose of enriching his manure-heap; but it could be easily shown that the margin for profit would be hardly less were he only able to grow those inferior kinds of grain which he uses in feeding. It is for this reason that, so long as the Scotch farmer relied on paying his rent by selling fat stock and grain, he never could afford to farm so high as the English.

It now remains for us to point out, a little more in detail, the elements of climate which determine the particulars of the opposite systems which experience has established. This can only be effectively done by contrasting the requirements of the various crops, with respect to cultivation and manuring, under various climatic conditions.

The most striking and marked difference in the cultivation of

cereal crops in moist and in wet climates is exhibited by the place which wheat occupies in the rotation. In moist climates it thrives best after a bare fallow or green crops, in dry climates after seeds. Throughout Scotland, Ireland, and the West of England, wheat is a somewhat precarious crop after seeds, and accordingly oats are in general substituted for it. It is somewhat difficult to account for this well-known fact, but there are probably two causes which are the principal in operation. In the moister climates the straw of wheat, unless in particular soils, seldom assumes a fine healthy colour when sown after seeds. The fresh decaying vegetable matter has the effect of producing a certain grossness in the plant which is not thrown off by the greater amount of direct sunshine that prevails in the drier climates. It is weaker in winter as well as in spring, and a thin plant is a frequent result, arising from depredations of insects or otherwise.

When the climatic conditions are thus less favourable, the health of the wheat plant is greatly promoted in its early stages by the soil being better prepared. Land that has had a summer fallow, or the benefits of cultivation which a root-crop insures, is in a much better state for allowing the young plants to run through the soil and gather food than after seeds. Wheat sown after green crops, such as potatoes or turnips, produces a more healthy plant and finer quality of grain than when sown after seeds.

Another still more palpable reason for wheat not succeeding so well after seeds in moist climates is the greater vigour of the grasses. These are worse to extirpate, and any that remain in the soil are not kept in check by the wheat plant in spring and early summer: the grass consequently grows up among the wheat, and the land is left in a foul and unthrifty state. When oats follow grass, the result is very different; they are sown broadcast over the ground, and a liberal allowance of seed insures a thickly-planted crop, which having the start of the grasses smothers them, or, at all events, prevents their growing with much vigour. To such a degree is this the case, that Mr. Acland, in his Report on the Farming of Somersetshire, mentions that, after grass, oats are taken "to clean the land," as the farmers say, and permit its being sown with wheat the succeeding year.

No plant seems so dependent on the physical properties of the soil as wheat; more especially in dry climates. One of the causes, therefore, of wheat succeeding better after seeds in these, is owing to the remains of the stems and roots of the seeds making up to a certain extent for the physical defects of the soil. It might be thought that this manuring in the vegetable form would chiefly act by retaining ammonia within

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the soil until it was decomposed and taken up by the roots of plants. By acting in some measure in fixing the nitrogenous substances, the vegetable matter might be supposed to prevent the wasting effects of rains: no doubt it does that also, but then it must be remembered that vegetable manuring answers best in the driest climates where there is least waste from washing. Mr. Hannam states this very strongly, in his article on green manuring, in 'Morton's Cyclopædia of Agriculture':—"It is only after a good crop of depastured seeds that a full crop of wheat can be grown upon the high and dry wolds and the limestone and chalk hills that are brought into cultivation in this country [south-east of England]. After turnips, barley upon such soils succeeds, but it is only upon lea that wheat can succeed fully, when the texture of the soil is light. No doubt manuring will answer upon fallow." The decaying vegetable matter seems to improve the physical texture of the soil by its attraction for moisture: it also, to some extent, regulates the supply of ammonia to the plants, by only slowly yielding it up—a matter of much economy in the feeding of plants. These influences combined have the effect of sustaining vegetation in a comparatively healthy state during periods of drought. Though the necessity for vegetable manuring is most strongly marked for wheat on light soils in dry climates, still all other crops exhibit its beneficial effects under similar circumstances.

The necessity for seeds as a basis for a full crop of wheat is not so much felt where the soil is argillaceous, even in dry climates. Soils of this character, by their retentive properties for moisture, can maintain the plants in a healthy state during periods of drought. The ammonia being also absorbed by the soil and rendered in a great measure insoluble, is only taken up by the roots as the plants require it; but as the climate becomes more moist, and just in proportion as it can better sustain the healthy growth of grass on light soils, so can it also that of wheat. The increased moisture compensates in both cases for the physical deficiencies of the soil, and the beneficial effects of green manuring are less apparent. Vegetable matter may be regarded not only as a good absorbent of moisture, but as the best dilutant of ammonia in a dry climate; in a moist climate it is less needed for these ends, and its efficacy is not so striking or marked.

These considerations are by no means in contradiction to the successful results of applying soluble manures such as the nitrates or salts of ammonia to wheat crops in dry climates. The last number of the Journal contains an admirable summary of numerous experiments on manuring wheat on the light lands at Holkham. No doubt clover lea forms the basis of success, which so far as regards the nitrates is dependent on their application at intervals

during the growing season; more especially during periods of moist weather, when the plant is in circumstances to turn it to the most advantage. It is not in dry seasons, when the soil is least liable to suffer from being washed by rains, that these soluble substances are most efficacious; but in wet seasons, when the real waste from such a cause should be greatest. Mr. Read with his usual practical sagacity justly remarks:—"Holkham is not the *natural soil for wheat.* In those wet seasons when there was so poor a wheat crop throughout the kingdom, the nitrate of soda produced the greatest results. . . . . The nitrate of soda and salt are best applied in two dressings: the first when the wheat takes its early start in February or March, the rest some time in April, when the wheat is growing vigorously."

The moister the climate, the more "natural" do light sandy soils become for the growth of wheat. The less necessary also is vegetable substance, as a means of sustaining growth. The plants in all cases feed on the same substances; but they are only yielded slowly up when applied in the vegetable form, which in some measure supplies the plants with a daily portion of food. This we can easily imagine is consistent with the most economical application of manuring substances. A large supply of nitrogenous substances existing in the soil in a fit state to be taken up by plants, can only be economically worked up when they have a due supply of moisture.

In moist seasons the English practice of sowing wheat after seeds no doubt aggravates their effects on the crop. The straw is more liable to become diseased than when it is sown after root crops. Under other circumstances this is still more strongly marked in practice. Indeed all our Scotch and English notions respecting the qualities of soil best fitted for the wheat plant are in a great measure set aside in North America, where the climate is entirely different. There the winter is so cold that the plant is completely checked in its growth until the summer bursts in at once. This season sets in hot as well as moist, and soils of light texture can sustain the growth of the wheat plant. Sandy soils thus become in the eyes of the American farmers quite "natural" for wheat. On the other hand, those which contain vegetable matter in large proportions are wholly unfitted for the growth of wheat, as it becomes too luxuriant and liable to disease.

It has been already stated that, in the presence of sufficient moisture, a higher temperature will go far to compensate for a smaller quantity of manure. The reverse is likewise true; a deficiency of heat is, to a certain extent, made up by a larger supply of manure.

It ought also to be observed that manure and temperature have somewhat similar effects on the flowering of plants. A deficiency

of temperature or of manure hastens the flowering processes, while a high temperature or an excess of ammonia retards them. These effects form subjects well worthy of careful analysis in estimating the influence of climate on the growth of crops.

A high temperature hastens the ripening of a plant after it arrives at a certain stage in its growth, but it has been generally overlooked that it has a precisely opposite one on its early stages. A turnip or a wheat plant has comparatively little tendency to seed when sown on rich soil in the month of June. Both, however, run rapidly to seed unless highly manured when sown in March. All plants seed soonest in the poorest parts of a field. Cold nights have a great effect in developing the seeding of plants; ammoniacal manures retard seeding by stimulating the growth of stems and leaves. Cold and drought then act to some extent in a similar way, by preventing plants from obtaining and appropriating a full supply of food.

It is also worthy of being kept in mind that when the climate encourages early maturity, it also has the effect of producing a smaller yield. What is gained in time is to a certain extent lost in quantity. The rapidity with which any annual comes to maturity is not favourable to its productiveness. In those cases in which earliness and productiveness do go together, liberal manuring must be resorted to. Manure is so far an equivalent for time.

In conformity with this principle, the productive powers of wheat are greatest in moderately cool and moist climates. Under these circumstances the plant expands more fully. By retarding its flowering tendencies, its stems as well as ears are formed upon a larger scale, and it is capable of yielding more on a given space. For this reason the wheat plant attains about its maximum powers of production in Great Britain, in those districts where the climate favours its ripening. On the other hand the productive qualities of wheat gradually decrease as the latitude lowers.

As a general rule too—one that, so far as we are aware, does not admit of any material exceptions—the latest varieties of crops are generally most productive when the supply of manure is moderate. This is not so well exhibited in wheat as in some other plants which we shall have occasion afterwards to point out, but still we can trace the principle distinctly enough. The longer the time that the leaves of any plant can present a green and fresh surface to the atmosphere, the more can it not only rely on the atmospheric supply of food, but the more food can it appropriate from the soil.

The success which has in some few instances attended thin and early seeding of wheat is no doubt partly attributable to the lengthening of the period of growth. It exhibits in fact all

the characteristics of a later variety. The individual plants, having more space to expand their roots in, form correspondingly large stems. The increased scale on which the plant grows enables it to maintain a larger absorbent surface of leaf. The seeding tendency of each plant is retarded by the larger supply of food furnished. Its lateness also causes its growth to take place to a greater extent during the warmer season, when the absorbing powers of the leaves are greatest. These elements no doubt contribute to the success of growing wheat at Lois Weedon with so little expenditure of manure; and whatever may be the other elements of success, these cannot be left out of view.

The practical effects of thick and thin seeding have been philosophically treated in the farming essays of Mr. Mechi and Mr. Hewit Davis. Thick seeding, by limiting the amount of moisture and manure to each plant, hastens its flowering processes. It need hardly be again observed that a deficiency of moisture and a deficiency of manure are similar in their effects upon plants: the want of moisture renders the presence of manure of little avail. Both, therefore, favour the early maturity of plants, which is well known to accompany thick seeding. Thin seeding, on the contrary, whatever may be its other disadvantages by limiting the number of plants and extending their growth over a longer period, is a means of economising both moisture and manure.

Temperature, humidity, manuring, and the physical properties of soils derive a considerable amount of fresh interest on viewing their effects on the growth of the wheat plant when sown in spring. A low temperature during the early stages of the common and finer varieties of wheat seems quite as natural to its productive powers as a high temperature to ripen it. When wheat, as already stated, is sown in warm climates or in summer, it exhibits little or no tendency to flower. In North America, where the heat sets in so suddenly after the cold of winter, none of the common varieties are sown in spring, as few of the plants will in that case produce seed that summer. The same circumstance is observed in the south of France; and even in the south-eastern counties of England, when the time of sowing is somewhat delayed, the plant puts forth a profusion of stems and leaves, and the high temperature, instead of pushing the plant rapidly into ear, at that stage of its growth, has a precisely contrary tendency. It no doubt has such an effect on a plant sown in the end of February or beginning of March, for the cold at that season fully developes its seeding tendencies. The cold nights and warm days, which are the characteristics of the climate of the eastern counties at that season, hasten it on so much that a full plant is difficult to obtain, even with a liberal allowance of manure. Hence these

combined influences render spring-sown wheat anything but a productive crop on medium soils in the eastern counties of England.

In the western counties and in Scotland, the climate is much more favourable to the growth of spring-sown wheat. The less stimulating temperature by day and greater humidity prolong the growth of the plant and develope it upon a larger scale, so as to produce much heavier crops with the same amount of manure. Light soils too, more especially in the west of England, sustain its growth. So much is this the case, that wheat almost grows as freely as barley, and it possesses one great advantage, that it is not so liable to lodge with rains. Any one who has read with ordinary care Mr. Read's account of the Farming of South Wales must have been struck with the contrast which it affords on this point of farm practice, when compared with Norfolk experience.

The experience of Scotch farmers is somewhat similar, with regard to the raising of spring wheat, to that of the Welsh farmers. East Lothian no doubt brings the crop to greatest perfection. It produces a fine sample of grain, and it also in general yields well. In many districts it may be sown at considerable elevations, but in such cases it is somewhat affected by cold and retentive subsoils. On these the plant usually lacks vital energy, it is long in ripening, and the quality of the grain is poor. The temperature in Scotland is little more then sufficient to bring spring-sown wheat to maturity, which circumstance renders the influence of soil very marked. The broken and irregular surface of the northern part of the island furnishes a great variety of soils as well as climate, and nowhere can the reciprocal influence of the two be studied to better advantage. This is a subject, however, that our limits forbid us from touching upon, otherwise than in the most general and cursory manner.

In the fens of Lincolnshire spring-sown wheats grow with great vigour. The soil being moist sustains vegetation in a dry and warm atmosphere, and up to the period of flowering the crop is usually most promising. Such luxuriance is, however, almost invariably deceptive, as rust and mildew usually destroy the crops before they ripen. Unless the soil is remarkably sound, luxuriant growths called into action by thin seeding or late sowing have a tendency to produce mildew in the warmer climates. Thin hoeing the wheat crop in spring on the light soils of Norfolk is now generally abandoned, in consequence of the slight covering of the plants which takes place in the operation having the effect of encouraging late tillering. Owing to the late tillered stems being more luxuriant, from having

a higher temperature to grow in, they are frequently attacked with blight before they ripen, and an irregular sample is the result.

The eastern counties possess a climate much superior to the west of England or Scotland for the ripening of wheat. The rich golden hue which the crops assume in the former just before harvest, is only seen in the latter in the finest seasons. It must not be assumed, however, that the lower temperature and more humid atmosphere of Scotland render it better suited for the growth of oats and barley than for wheat. No doubt, under the necessity which the climate imposes upon the Scottish farmer to sow oats instead of wheat after seeds, it is more difficult to have such a large proportion of his land under the wheat crop. Inferior grains, such as oats and barley, are raised at less cost in culture and manure, and yield as great a net produce. That, during a series of years, the wheat crop brings in the largest money return to the Scottish farmer, is well brought out in a table in the appendix to the 'General Report of the Agricultural Society of Scotland,' by Sir John Sinclair. An account is given of the produce of wheat, barley, and oats, on an imperial acre, for fifteen years—from 1781 to 1795—on a farm in Clackmannanshire. The average produce and average value were as follows:—

				£.	*s.*	*d.*
Wheat	30	bushels	.. .. .. value	7	13	$9\frac{3}{4}$
Barley	35	,,	.. .. .. ,,	4	17	$11\frac{1}{2}$
Oats	$37\frac{1}{2}$	,,	.. .. .. ,,	4	6	$0\frac{1}{2}$

It ought to be observed that the produce of both oats and barley per acre vary more than that of wheat. Thus, the best crop of wheat was in 1790, the produce being 34 bushels to the acre; the worst in 1788, the produce being $20\frac{1}{2}$ bushels. In 1788, the produce of barley was $49\frac{1}{2}$ bushels to the acre, but fell as low as $10\frac{3}{4}$ bushels in 1782. In 1791 the produce of oats was as high as $48\frac{1}{2}$ bushels, and in 1782 as low as $23\frac{1}{4}$ bushels.

Wheat, when sown in autumn, upon a sound and well-prepared soil in Scotland, is really less under the influence of those agents that affect the produce of the spring-sown crops. This was more especially the case in former times, when it was the general practice to sow oats and barley later in the season; for in these circumstances the crops are much more liable to be affected with drought or heavy rains during the seed time. A crop of autumn-sown wheat on a good soil is comparatively independent of spring droughts, and the chief risks which it runs are bad blooming and ripening seasons.

The effects of climate on the growth of the *barley* crop will now be considered. These are even more marked than in the case of the wheat crop, and afford still more striking illustration of the

effects of temperature, humidity, and manuring, of which we have endeavoured to trace the separate influence in the case of the wheat crop. The climate of the eastern counties exhibits a far greater superiority over other parts of the island for the growth of barley than for wheat. The Scotch farmer may often grow as fine quality of wheat as the English, but, unless in a few localities, the inferiority of the barley is very manifest.

Wheat, too, when sown either in autumn or in spring, will bear an amount of forcing in moist climates, under which barley in the same circumstances will fall down and yield a poor return. On all the secondary climates in Scotland, where the soil is suitable, wheat is invariably substituted for barley as the treatment with respect to manuring becomes liberal; for it must constantly be borne in mind that, unless from local circumstances the farmer in a moist climate can advantageously sell a portion of the green crop off his farm to remunerate him for a liberal expenditure of manure, he cannot expect a remuneration from increasing the produce of oats or barley: even at best, the partial substitution of wheat for barley must be carefully gone about. In moist climates, instead of farmers growing a large breadth of green crops, it is more generally the practice to grow white crops in succession, as they can be raised with less expenditure of manure.

Thus Mr. Garnet, in his 'Report on the Farming of Lancashire,' says, in regard to one district of the county:—"The rotation of crops which is now adopted with success in working and restoring the land is a five course, as follows:—1. Oats. 2. Oats. 3. Green crops manured, turnips or potatoes. 4. Oats or barley with seeds. 5. Seeds for hay or pasture." Mr Tanner, 'On the Farming of Devonshire,' remarks:—"The rotation of crops adopted in this country is known as 'the old Devon course,' or turnips, wheat, barley, oats, seeds, two to six or more years." Mr. Read, 'On the Farming of South Wales,' states:—"Experience has proved that, on the better lands, barley, after a drawn crop of turnips, will frequently lodge. Even Mr. Morgan, in his prize essay on the 'Cropping of Pembroke,' admits, 'barley on some soils is not a safe crop after turnips.' Although the following course cannot be defended on the principles upon which the rotation of crops are founded, yet it is practically found to be one best suited to the good land of this district:—1. Turnips. 2. Wheat. 3. Clover. 4. Wheat. 5. Barley. To give a few specimens of the rotations pursued in Ireland when Arthur Young made his tour through the country, would only show still more strikingly the facility with which a succession of white crops can be taken in moist climates, and the general neglect of turnip cultivation."

Barley, like every other crop, the later it is sown in spring, the

less manure it requires to produce a given quantity of grain. Where it is the custom to take repeated crops of grain, late sowing is invariably had recourse to as a means of augmenting the produce. Mr. Read, in his 'Report on the Agriculture of South Wales,' states, that "the season for putting in barley is generally from the first week in April to the middle of May."

In the south of England, where the heat of summer is greatest and the drought most severe, barley of fine quality is rarely obtained, if it is put into the ground later than the middle of April. Even in favourable growing seasons the crop rushes up too rapidly, and the high temperature of July forces it on to maturity: as a consequence, the grain is hungry and inferior in quality. In fact, in ordinary seasons the forcing character of the weather is such in the south of England that the spring crops usually ripen much about the same time, whatever may have been the time of sowing.

It is, therefore, of prime importance to sow barley early in a dry and forcing climate. When the land is well manured, it pushes the plants forward, although the season is cold and ungenial. The earlier, in fact, that the crop is sown, the more does it show the advantages arising from winter sowing. Mould pulverized by frost is best fitted for retaining moisture: the straw, too, from having had time to take a full supply of earthy matter, is said "to contain more bone," and is altogether more healthy and of firmer texture, which enables it to withstand the effects of rains. But perhaps the chief advantage arises from the seeding tendencies being fully developed; for the cold has the effect of promoting seed, and the manure is also diverted towards this primary object. The grain, not being unduly hastened to maturity, becomes plump and fine in quality. It is a just observation of Mr. Hewit Davis, that the season for sowing land in good condition *begins with the year*, and no favourable opportunity after this period should be lost in committing the seed to the ground. This is also quite borne out in the opinion which we have heard Mr. Hope, Fentonbarns, East Lothian, express. He prefers to sow barley, as well as other spring crops, by the end of February, if the soil is in a fit state and well manured. Early sown crops do not often suffer from the low temperatures that occasionally occur, and they are rendered far more certain and productive.

In Scotland, however, it is under certain circumstances advantageous to delay the period of sowing barley. In some of the more elevated districts, where the soil is strong and not well adapted for grazing or for turnips, barley is generally taken after a crop of wheat. In this case the land is somewhat low in condition, and delaying the sowing till the beginning of May greatly

increases the productiveness of the crop. A century ago barley was rarely sown before the month of May, as the sources of manure were then exceedingly scanty. This is still more forcibly brought out in former times in the cultivation of bere or bigg, the four-rowed barley. This variety was usually sown in the beginning of June, and was still less dependent on a supply of nitrogenous manure. Indeed, it was thought to exhaust the soil comparatively little, as it could be raised on ordinary land for many years in succession with the slightest dressings of manure.

These facts show that barley may be sown late in the season with advantage in the cooler and moister parts of Britain. In such circumstances it can be grown with less manure, which to a certain extent acts as a compensation for the inferior quantity and quality of the produce. One of the most direct effects of this, however, is in retarding the general introduction of improved systems of farming, in which green crops occupy more attention. On the poor soils of Norfolk neither barley nor wheat can be got without turnips, whereas in moist climates very different practices may be followed with a greater measure of success; and the necessity for turnip culture not being so imperative, the crop is only slowly introduced even in those districts where the climate is best suited for its growth.

The effects of the physical or mechanical properties of soil on the growth of barley in relation to climate is in some respects different from that of wheat; these differences, however, have not a little to do with the seasons at which the barley crop admits of being sown. The stiff clay soils of Suffolk and Huntingdon we usually recognise as well fitted for the growth of wheat; but, through the improved methods of cultivating these soils, they have become admirably adapted for the growth of barley. The rotation adopted—of clover, wheat, fallow, barley—permits of the soil being reduced to a fine tilth by the winter frosts. The finely pulverized mould sustains the growth of the barley crop as well as the finest turnip loams. Under these circumstances, the vegetable manuring of the clover crop acts more beneficially on the wheat which follows it than it would on the barley; indeed, this crop is much sooner injured by an excess of vegetable matter in the soil than wheat: the latter is cultivated with success in the humus soils of the Lincolnshire fens, where barley does not thrive. In moist and humid climates barley is very susceptible of vegetable matter, and where it abounds becomes gross in its habits. Its use is most advantageous on the lightest soils, as is also the case with wheat, rendering them better fitted for sustaining growth in dry weather.

As the climate increases in aridity, so must the soil improve in its physical properties, to maintain the healthy growth of the

crops. A sandy soil is well known to be naturally more fertile for cereals in a moist than in a dry climate. So, on the other hand, careful tillage, having for its object the improvement of the physical properties of soils, by rendering them more retentive of moisture, is more required in dry climates. The painstaking management which the Norfolk farmer pursues in pulverizing his weakest sands for a crop of barley contrasts strikingly with that followed in moister districts. Mr. Peirsen, Framlingham, Suffolk, writes, in Messrs. Raynhird's 'Farming of Suffolk:'—"On light soils that have been sheep-folded it is a common practice to plough three times: by this means the manure is more equally dispersed, and experience has proved that a dry summer does not injure the barley so much as it does when the land is ploughed only once." Arthur Young, and other early writers on agriculture, drew attention to the careful cultivation of the light lands for barley in the eastern counties as a means of resisting the effects of drought. In cool and moist climates ploughing sheep-folded land more than once where the soil is light has never been practised as a system; nay, it is too often supposed that pulverizing light lands in the spring rather has the effect of dissipating the moisture than of rendering them more absorptive and retentive.

The necessity which the Norfolk farmer felt for having his land thoroughly comminuted for the production of spring-sown crops also paved the way for the general introduction of sowing by the drill: this implement has only slowly extended in moist climates; one reason, no doubt, being the less careful culture which the land receives, and where late sowing is followed it is of no advantage. The crop then grows rapidly and keeps the weeds in check, and the use of the hoe is less needed for this purpose. It is of more importance to have the seed distributed equally over the land when the time of sowing is delayed, as there is then less time for the crop to send its roots throughout the soil; hence wide drilling for cereals can be followed advantageously for autumn sowing, but narrower intervals are preferable as the season advances.

The influence of climate on the productive qualities of the *oat* crop is so well recognised that it will be unnecessary to dwell long upon the subject. It is a plant that requires a larger amount of moisture than either barley or wheat: the latter two become plumper and thinner in the skin when the temperature is moderately high during the ripening season: on the other hand, oats lose their plumpness under a high temperature—they become lean and light in weight.

In even moderately moist and cool climates, oats are more fluctuating in their produce on light soils than any other cereal.

Requiring a considerable quantity of moisture to maintain their healthy growth, they are easily hurt during periods of drought, and are not remunerative for liberal treatment. Were it not for the difficulty of keeping such soils clean, wheat would yield nearly double the value oats would do; but oats, checking the growth of weeds in their early stages, leave the land much cleaner and more easily managed when under preparation for green crops. On the other hand, oats generally turn to good account nitrogenous manures applied on clays or deep loams; they are not so liable to suffer from over-luxuriance as barley, and are altogether a much grosser feeding plant. Soils abounding in vegetable matter yielding nitrogen afford manure to the oat crop in the best possible form.

It is generally found that the latest varieties of oats are the most productive: though this is best seen when cultivation is in a backward state. In Scotland, when the soil was poorer and in a worse condition, the harder and later varieties of oats were preferred. By their growth being extended over a longer period, they had greater powers of abstracting food both from the soil and atmosphere. The potato oat is no doubt a productive variety, but it requires to be early sown and liberally manured to yield well.

Kilwhiss, 1859.

XIII.—*Account of the Application of Steam Power to the Cultivation of the Land.* By John Algernon Clarke.

Prize Essay.

After some three hundred inventions in steam culture have received the protection of the Great Seal—from the seventeenth century to the present time; after the working out of numerous ideas for this object, not to be found among the blue pamphlets of the Patent Office; with the steam plough "a fact," and thousands of acres in Great Britain broken up or turned over by steam-driven tines and shares,—it is high time for the Society's Journal to sum up the extent of our progress in realising the great triumph of agricultural mechanics and the farmer's long-expected boon. The history of steam ploughs, steam grubbers, steam spades, and novel machinery for tilling by new modes of action unlike those of manual or animal labour, would be a long story; and speculations upon what might have been accomplished with contrivances never carried beyond the embryo of promise on paper, would be of small moment in comparison with descriptive particulars of mechanism really tested and laboriously improved

by degrees in the field. Accordingly, the "heads" specified for the present paper embrace—*first*, "a general description of the methods now in use, and of such success as has been attained;" and, *second*, "a detailed account of one or more cases where steam power has been employed in the ordinary cultivation of a farm."

The "methods now in use," and, indeed, all forms of steam-cultivating apparatus, are based upon two distinct principles, and may, therefore, be classified thus:—Steam machinery *dragging "traction implements,"* and steam machinery *tilling the ground by other means.* And then, as an accessory to the primary purpose of tillage, or the mechanical preparation and treatment of the soil, we have the *locomotion of steam-engines in fields and upon common roads.* Incidental to the subject, there are also the manipulation of crops in the field, weeding, manuring, dressing, &c.; but all these are subsidiary to the main operation of "tillage."

I will first devote some little space to the consideration of

Machinery Acting Independently of Traction.

Although the application of steam power to the hauling of implements has been eminently successful (as will fully appear in the course of this paper), producing a better description of work, operating at less cost, and enabling the condensation of preparatory tillage into suitable moments to a greater extent than could be attained by any amount of horse-labour, still there are those among us who look for a yet greater economy and a more garden-like process of culture when steam is set to grapple with the soil in its own way, instead of being merely substituted for horses in doing horses' imperfect work. I shall not quote the conclusive teachings of the "Clay-farm Chronicler" on this point, but simply endeavour to point out the promised and partially-realised advantages of the rotary tillage he advocates. And I am happy to say that none of those multitudinous inventions are at present before the public which aim at imitating the action of spades, mattocks, or other hand-tools, by means of arms, cranks, eccentrics, joints, slides, and levers,—a complicated mass of moving parts foreign to the portability and simple utility of a farmer's field machinery. We have only machines for cultivating by the continuous circular motion of a shaft or cylinder, armed with shares or cutters, driven more or less directly by the engine. Now, the operation of tillage consists in thrusting into or passing *a wedge* through the soil, and then lifting (or not) the separated portion; no matter whether the wedge has a horizontal rectilinear motion, as a ploughshare or grubber-tine,

or a circular motion, as the cutter of a revolving digger. In separating the slice or spit, the wedge must necessarily compress and glaze it in some degree; but the reacting pressure and sledging upon the sub-soil or whole ground of the under side of the share or cutter (so complained of in the horse-plough) may be altogether avoided in steam-power tillage.

Thus, in the Woolston grubber, the downward pressure is sustained by the travelling wheels, which run upon the surface of the land; in Mr. Fowler's balance-plough it is also borne by the wheels; in Mr. Halkett's ploughing apparatus it is carried by the wheels running along the guideway-rails; and in rotary cultivators it is sustained by the axle in its bearings. So far there appears to be little difference between these modes of operating, as regards the amount of compression due to the cleavage of the wedge,—that is, the blade, share, or cutter used. And both traction and rotary cultivators may either "cut" the whole breadth of their work (as in paring) or save friction by leaving spaces between the shares, where the soil will break up by its own rigidity. And both may employ tines of such a form as to tear the soil and draw out root-weeds, rather than cut them into short lengths. But, in the operation of raising and turning over the torn or sliced pieces, the revolving cutter that carries up a spit of earth (inverting its posture as it rises up), and then lets it fall, works with less expenditure of power than the plough-mouldboard, that prises and thrusts over a furrow-slice, with its screw surface hard rubbing all the time.

The great mechanical advantage of the revolving steam-driven digger consists, however, in the almost direct action of the motive power upon the soil; the engine actuates a drum (by the necessary gearing), and that drum does the cultivation—not hundreds of yards off, but there underneath it, passing shares through the soil as it rotates. What an economy of power compared with the traction system, in which the said drum, instead of carrying the tines or shares, has to pull a great length of rope, losing power in the mere maintenance of a requisite tension, besides that consumed in the friction of pulleys and supporting rollers, or in trailing along the ground; and the rope is not cultivating any more than the drum, but is a mere intermediate communicator of power to the distant machine which carries the tines or plough-shares. Then there would be a great saving of wear in working, as well as of time and labour in conveying from place to place, when the machinery is all comprised in a single self-moving engine, having neither implements, ropes, anchorage, nor other detached parts to be set down, laid out, taken up, and transported; and we must not forget another point of importance—that is the capability of the rotary digger

for accomplishing, at one operation, either the turning-up of rough spits or the pulverising of fine mould, and this at depths hitherto unheard of, excepting in spade-husbandry.

But now let us look at the difficulties to be overcome, and the measure of success already attained by various inventors. Breaking away from traction implements altogether, even from the idea of rolling-forkers, you have to devise cutting shares, or blades, or picks adapted to rotary motion; and, an infinite diversity of form being open to us, only experiment can determine what peculiar cutter is best suited to certain ends. Then, in applying the power: if the digger be attached to a locomotive engine, power is required for propelling a ponderous machine at a slow pace over the ground, and on lands where the inclines are steeper than say one in eight or ten, this swallows up all the mechanical advantage otherwise gained. A portable steam-engine alone is a very heavy weight on moist arable land; and when a massive framework and machinery are added, the travelling-wheels are liable to sink into the soil, not only rendering a great expenditure of force necessary for propulsion, but injuring the ground by undue consolidation. It is difficult, also, to avoid fine and complicated mechanism, very costly in the first outlay, and too expensive and troublesome for the farmer to keep in order in regular field-work. And, indeed, there may be wheels, and pitch-chains, and connecting-rods enough to absorb all the promised economy of power, and cause your cultivator to compare discreditably with the rope-traction system. On steep hill-sides, of course, a locomotive cannot travel; and wire-rope haulage, with its own especial implements, must be resorted to, unless rotary delving be found so effective a process as to be worth accomplishment by the method of transmitting power from a stationary engine with a rapidly-flying endless hemp rope.

Now, the idea of attaching radial cutters about a shaft or drum having a rotary motion *not derived from its own rolling* is very old, although newer than that of rolling cultivators. In July of the year 1846, Messrs. Bonser and Pettitt patented a tiller, formed of a cylindrical shaft or drum, having a number of radial cutters, prongs, or tines, either straight or curved, attached to it at right angles and arranged round it spiralwise, so as to present the appearance of a screw. This tiller was placed across the back of the machine, with its axis at right angles to the direction in which the machine travelled, and it was caused to revolve by toothed gearing with considerably greater velocity than if it had simply rolled, the direction of rotation being the same as that of the carriage-wheels of the machine; so that the cutters entered the soil downwards, tossing the crumbled earth backward, and their action tended to propel the machine for-

ward, just as a paddle moves a steam-boat. As the wheel-work actuated the tiller from the axis of the carriage-wheels or broad-roller supporting the framework of the machine, the motion of the tiller was derived from the traction of the machine, just as that of a drill cup-barrel is; but the patentees contemplated the use of "any other suitable motive agent" as well as horse-power, and a steam-engine mounted upon the platform of the machine, and driving the travelling-wheels, would have embodied the principles of action followed in subsequent inventions.

In July, 1847, Mr. Paul patented a revolving drain-cutter and a revolving subsoiler—the latter consisting of a horizontal axle, supported by a frame for raising or lowering it, and having several naves or bosses, with curved tines or teeth affixed to them, and midway upon the axle was a wheel driven by an endless chain from a horse-power windlass, which slowly advanced, dragging the subsoiler behind it. The teeth, when in the ground, travelled in the same direction as the machine, making their cut upwards, and so bringing up the sub-soil in front of the axle; whereas in the former machine the cut was downwards, moving the soil backward. This action of course opposed the onward progression. In October of the same year, Sir John Scott Lillie patented a tillage apparatus,—including an axle extended horizontally across a carriage, and driven by toothed gearing from one of the travelling-wheels, or more directly from a steam-engine placed upon the machine, the carriage itself being propelled by the engine winding along a fixed rope. Radial or curved pins, tines, hoes, or suitably-shaped points, for breaking up the land, were fixed on this axle, and, rotating rather rapidly in a direction opposed to the machine's advance, broke up and comminuted the ground.

In July, 1849, Mr. James Usher, brewer, of Edinburgh, patented a more successful cultivator, to which I must devote a little space. A portable steam-engine is mounted upon a framework mainly supported by a pair of broad-felloed wheels or a wide roller, and also by a front pair of wheels turning in a transom for steerage. A lever-frame at the back of the carriage supports a horizontal transverse shaft, which may thus be raised or lowered at pleasure, and both this shaft and the main bearing-wheels are driven by toothed gearing from the engine crank-shaft, the wheels rotating so as to give a slow progressive motion to the machine, and the shaft revolving at greater, though moderate, speed. On this shaft are fixed four or more discs or plates, each carrying three ploughs of a curved form, so arranged that no two shares strike the ground at the same instant. These ploughs (or teeth, tines, or other instruments) penetrate the earth in the opposite direction to that in which the machine is

advancing, thus propelling it, the spur-wheel on the carriage-wheel axle regulating the rate of advance. This principle of action is the chief source of economy in power in driving a rotary tiller: the shares encounter resistance to their passage through the ground, and, by moving them in the right direction, you may take advantage of this reaction, and, while applying the whole of the motive power almost directly to the digging-shaft, have the machine moved onward without any separate assistance from the engine, simply in consequence of the direction in which the cutters move. If three shares at a time be constantly passing through the ground in a backward direction, with a force (or draft) of say 6 cwt., the machine is urged forward with a force equal to 6 cwt., or the draft of three horses—sufficient for its propulsion at the very slow pace required. And in this way Mr. Usher completely overcame the objection as to "waste of power" in transporting the engine over the land. The first machine was built by Mr. Slight, engineer, of Leith Walk, Edinburgh, and was tried in work during the latter part of the year 1851 and the spring of 1852. The engine was of 10-horse power, and the weight about 6½ tons; and it is certain that the propelling action of the rotating tillers not only enabled it to mount inclinations which it could not cope with by the mere adhesion of the broad roller upon which it travelled, but that no part of the motive power was engaged in effecting the onward motion. Indeed, it was considered at the time that the thrust of the slowly-moving shares was more than sufficient for the propulsion of the machine. For in some of the experiments, when the land had been dug up for the first time, the machine was immediately taken over it again, working as easily as at first; and 6½ tons, riding upon a wide roller (not of large diameter) and a pair of wheels, across soft freshly-moved earth, at a pace of 3 miles an hour, evidently required the full power of the engine, while a breadth of 4 feet 2 inches was being ploughed up deeply at the same time.

Mr. Usher having made several important improvements, again tested the machine at Niddry Mains, near Edinburgh, in February, 1852.

"The soil is left in a broken condition, as by the fork or spade, and arrangements exist by which the three operations of manuring the soil, sowing, and covering in the seed, are done at the same time. It travels at the rate of three miles an hour, equal to 9 acres a day, or, allowing for turning, stoppage, &c., say 7 acres, which it has done in its various trials, for an expenditure (working expenses) of 17*s.* 6*d.*, or 2*s.* 6*d.* per acre. It travels well on common roads, ascending acclivities of one in ten, and turning round in a circle of 16 feet diameter, and is adapted for any other purpose to which steam-power is applied."—*Professor John Wilson*, at the Royal Institution, February 25, 1853.

In the spring of 1855, another machine was completed, having

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an upright boiler; double cylinders; a different arrangement of toothed gearing for communicating motion to the tilling shaft and to the travelling wheel; a movement by which the tilling-part was lifted or lowered by the power of the engine; smaller mould-boards to the curved ploughs; and minor improvements as to the engine pumps, &c. The weight was about a ton less; and by having 210 feet instead of 130 feet of heating surface, there was a great increase of power. At the Carlisle Meeting, in 1855, this engine was exhibited in the showyard, but not at work in the field; 6 horses drew its weight of 5½ tons; and though supposed to be of 14 horse power at 50 lbs. pressure, the friction-brake gave the power as 19 horse. The "tiller" of this machine makes 30 revolutions per minute; the rate of advance is 95 feet per minute; and as there are three plough cutters on each disk or plate, making thus three cuts in each revolution, each share strikes the ground $12\frac{2}{3}$ inches in advance of the last in the same track. The depth varying from a few inches down to 9½ inches; and each cutter taking a breadth of 10 inches, the ground is severed into curved flakes or spits. The wing or small mould-board on one side each share is not turned over as in the common plough, and does not even rise to the perpendicular, but yet, owing to the speed, throws the piece of earth over sideways; and this piece falling before the second cutter of the preceding set, is again broken up and further comminuted. Neat inversion is not attained; but less stubble was left on the surface (in the former trials) than is often the case with a common plough,—the little left being quite shaken to pieces, so that the harrow which was attached to the back of the machine raked all off the land. The breadth of ground taken at one time is 50 inches; equivalent, at the stated rate of advance, to 2635 square yards per hour, or $6\frac{1}{2}$ acres in 12 hours. Time is lost, however, in turning at the ends and crossing over the land—the machine throwing its work only one way; but the inventor considered that steam-power should be used in a continuous progression, without stoppages except for taking in water, beginning at one corner of a field, or in the middle, and going round and round until it was finished. An association was formed for carrying out the scheme with 10*l.* shares, including two dukes and various baronets among the subscribers; but unfortunately this ingenious invention has been no more heard of in the agricultural world.

In December, 1852, Mr. John Bethell patented a rotary digger attached to an agricultural steam-engine. It consisted of a drum or shaft, round which are arranged in a helical direction a number of prongs or tines. This digger turns in bearings made at the end of a frame, or a pair of lever arms, secured to the back part of the engine carriage in such a manner that it may

be raised or lowered when required, and motion is communicated to it by means of a band passing from a rigger on the engine crank-shaft to another on one end of the digger shaft. The machine was drawn forward by horses, and the steam-driven tiller cut away the earth and threw it backwards. In January, 1856, Mr. Bethell stated at the Society of Arts, that,—

"He had been working this machine for three years with various alterations. It dug like Parkes' steel fork, and left the ground in a perfect state of tilth after the separation: it threw the earth up into the air; the earth falling first because the heaviest, and the weeds coming upon the surface. They had no difficulty in working about 4 or 5 acres a day with that machine. It dug down to the depth of 9 inches; and farmers who had seen it working had stated that it did as much in one operation as would require two or three ploughings to perform, besides scarifying, harrowing, &c. The estimated cost of it was about 9*s.* an acre; whereas 23*s.* was stated to be the cost under the ordinary mode. The experimental engine was worked at a pressure of 45 lbs., but the one he was about to construct would work as high as 100 lbs. to the inch."

Since then, namely in October, 1857, Mr. Bethell has further patented the attaching of a revolving forker behind a locomotive engine, having the Boydell rails upon its wheels. And certainly, the addition of endless rails or shoes of some kind, is indispensable for bearing up the weight of a ponderous locomotive-engine and its machinery, in order to prevent injury to the condition of the soil.

In May, 1853, Mr. Robert Romaine of Peterborough, in Canada, patented a steam cultivator, consisting of a sort of cart on large broad-tired wheels, carrying an upright boiler and engine; a lever frame extending behind and raised or lowered by an adjusting screw, supported the digging cylinder. This digger was constructed with a number of bars armed with picks, knives or teeth; and was driven at a high velocity. But horses were employed to draw the machine forward: an incongruous contrivance that failed to answer in the experiments made upon Mr. Mechi's farm. In August of the same year, Mr. Chandos Wren Hoskyns patented (for the sake of protecting the idea propounded by him in 1851) the steam rasp with which his readers are familiar; and which I must describe for the sake of the principle involved, though it has never appeared practically before the public. The object of this invention is to accomplish at one process the due preparation of the soil, more especially clay soil, for a seed bed: this result being obtained by a machine which, instead of lifting in mass the stratum of earth under cultivation, like the plough or spade, is so applied to the soil as to reduce it by abrasion to the required tilth or fineness. This abrasion is performed by a series of discs or wheels, fixed on a rotating axis actuated by steam power, the periphery of which discs are

furnished with radiating points or cutters. The rotary motion of the discs is communicated from the steam-engine, from which also the progressive motion of the machine is derived. The two motions are independent of each other, and so arranged that a rapid motion may be given to the cutters, while the progressive motion is slow or suspended altogether, as at commencing. The gearing is such that the respective speeds can be varied at pleasure to suit the nature of the soil. The cutters by their rotary action first enter the soil, making a semicircular trench, which during the progress of the machine is constantly preserved at the required depth; and the soil, abraded and cut down as the machine advances, is thrown off tangentially behind, and deposited in a comminuted, inverted and aerated condition. The machine is mounted on two pairs of very broad wheels or rollers, the pair used for propelling being made with ribs across the periphery, to ensure a sufficient bite or hold upon the ground. Of course, a rapidly revolving grating-cylinder could exert but a trifling propulsive action; and the power required to cut up a stratum of firm soil into earth-sawdust is enormous, so that with any ordinary steam engine, the operation would be tediously slow and exceedingly costly. One of the most carefully studied but the earliest of steam rasping or scratching machines, is calculated (according to the inventor's "specification") to advance, with a very powerful engine, about 200 lineal yards per hour; so that a width of even 3 yards would not accomplish more than 1¼ acres a day. And the first machine of Mr. Romaine, which from its high velocity minced and powdered the soil, was found to demand far greater motive power than could be feasibly applied; the conclusion from the experiments being that such a material as the land must be dealt with in masses larger than mere dust, and must be cut and raised by a slow steady motion. It is quite true that the efficacy of a manure greatly depends upon the extent to which it is amalgamated with a pulverized soil. Dr. Voelcker says, "On clay land superphosphates are of no use unless the land be properly pulverized. Some farmers imagine that by using the best artificial manures they do not require so much labour, or any additional labour. There can be no greater mistake; for the best artificial manures often fail, more or less entirely, for want of proper pulverisation of the soil. It is of the greatest consequence that the land on which artificial manures are used, should be in a high state of subdivision." And the evidence of all agriculture and horticulture combined, fortifies the Tullian principle and Lois Weedon practice of gaining fertility by means of a fine mould that infinitely multiplies the absorptive superficies of the acquisitive earth. But the indispensable value of a comminuted seed-bed, and the utility of a

seed-bed comminuted mechanically, are two different things. In the latter case the particles are all dry and ready to seize and coalesce with each other with the cementing moisture of the first rain-fall ; but when wrought down from a state of clods by the natural process of weathering, they are independent and repelling rather than inclined to suck and adhere to one another, their pores being replete with the moisture which has burst them into atoms out of solid cakes and slags ; and thus we have both a cheaply obtained comminution, and a more permanent mould for the elements to permeate, and for roots to roam and feed in. We have learned, therefore, to prefer cutting or tearing and lifting the soil in mass, as the spade does, though not in spits too thick or unshattered,—asking for very fine pulverization, only near the surface (which the gardener rakes) when seed is to be planted ; and laying up rough lumps in ridges or openly exposed when we are to leave it mutely beseeching the gifts of atmospheric enrichment.

Before quitting the subject of granulating the soil by a steam-power rotary tiller, I must mention another form now before the public—a portion of Mr. Halkett's cultivating apparatus, patented in October, 1855. Underneath his wide-spanning stage or platform travelling along the guideway-rails is fixed a rotary implement, much resembling a long-toothed Norwegian harrow, though only a single axis, with the rowels fast upon it, and this is carried forward endwise, or in the same direction as its length, at the same time revolving at a high velocity by means of driving-shafts and bevel gearing from the engine. The land is previously ploughed, and then follows " the comminutor," reducing obdurate clay to a state of the finest tilth : it leaves a semi-circular trench or furrow behind it, and cuts the ground, which it tosses sideways into a seed-bed fine as a molehill for the depth of 5 or 6 inches, while the depth of the previous ploughing may be much greater. The action, in fact, resembles the pulverizing of Hanson's potato-digger, and, as in that machine, a screen is used (when the soil is free from large stones), and by this means the clods not at first broken are thrown back upon the tines for a second or third blow. Mr. Halkett has found, in working the machine, that the roots of couch and other weeds are blown over the top of the instrument and deposited on the unbroken land, where they may be raked up with facility. A hopper is provided for distributing and intermingling artificial manure among the shower of pulverulent mould.

Mr. Romaine's cultivator appeared in a new shape in the year 1855, being built at Montreal and sent over to Paris at the time of the Exhibition. It propelled itself over the ground, but was a very imperfect machine, being defective in the boiler and in the

steering apparatus; nevertheless, it was at work during the summer in the plains of St. Denis. A third and then a fourth machine were built by the trustees of the Beverley ironworks (under the management of Mr. Alfred Crosskill), and tested from time to time during most of the summer and part of the winter of 1856, and in the autumn of 1857, with many improvements in the strength and durability of the working parts. The fourth machine consists of a double-cylinder 12-horse engine, with framework and machinery, mounted upon a pair of very high broad-felloed wheels, with two smaller wheels in front for steerage, and a fifth small wheel, also behind, for regulating the depth of the digging. Parallel connecting-rods, like those coupling the wheels of a railway locomotive, are used for transmitting motion from the toothed gearing at the fore part of the machine to the digging cylinder behind, allowing it to be lowered by toothed-rack, screw, &c., for any requisite depth of work, or raised above the ground for travelling. The digger is driven with a speed of some forty or fifty revolutions per minute, while the main carriage-wheels are made to rotate slowly, giving the machine a rate of progressive motion of about a mile an hour. The front wheels are hung on the same principle as chair-castors, enabling the steerage to be effected with great facility; indeed, by setting these wheels at right angles, or nearly, to their straightforward position, and actuating only one of the main wheels while the other is left stationary, the machine is turned short round in a circle the diameter of its own length, that is, about 15 feet. The digging cylinder is wide enough to project several inches on each side beyond the bearing-wheels, thus obliterating their track and allowing them always to travel on the unmoved ground; and the machine, being turned short round at each end of the field, passes alongside the breadth last cultivated, leaving two narrow headlands to be finally dug up, and tilling the most awkwardly angular corners without trouble or loss of time. The machine is also perfectly independent of horses, travelling of itself from place to place over moderately level roads or arable fields, and, when not used for cultivation, can draw a thrashing-box to a farmyard and drive it, or a corn-mill, or a saw-mill, or a pumping-apparatus, or whatever machine you please, by a strap from the engine flywheel. Now, as to the nature of the tillage performed. The digger consists of a hollow cylinder or barrel of boiler-plate iron, 2½ feet in diameter, hung horizontally across the back of the machine, and around this are fastened by bolts and nuts the cutters, somewhat resembling Coleman's scarifying paring-shares, with curved stems. They can be quickly attached or removed, and are strong enough to enter the hardest ground, or encounter roots, small stones, &c., without injury. When set to skim 3 inches deep,

these blades or hoes slice or shave off portions of the soil, leaving the stubble, weeds, &c., exposed on the surface ready for extrication and removal: when lowered to 6 or 7 inches, or any greater depth, the ground is cut and broken into small spits, which are mostly inverted as the shares emerge from the soil behind the cylinder, the subsoil in 10-inch deep digging (or in 12 to 16-inch work, which is practicable) being upturned and intermingled with the top staple, while the surface-sward or stubble is sufficiently well buried. The land is reduced to any degree of fineness, according to the number of knives in use. I have seen its work on tenacious soil, and can testify to the truth of the following terms employed by various well-known practical men to describe what, in fact, resembles most the forking or digging of spade-husbandry.

"I have never seen work put out of hand and left in such a perfect and complete state for the operations of the agriculturist, by either spade, plough, cultivator, or any other implement I have ever seen in use. My friend Mr. Benson (the Duke of Devonshire's agent) was equally pleased."—*Mr. Joseph Tiffen, of Skirlaugh, Hull, agent to Mr. Bethell*, Sept. 23, 1857.

"The cultivator certainly does its work most perfectly, leaving the land sufficiently pulverized to be quite ready to receive the seed, provided the land be free from couch-grass."—*Mr. George Wood, of South Dalton, Beverley*, Jan. 14, 1858.

"My opinion of the steam-cultivator is that the work will never be excelled by steam power, but that the machinery can be and will be simplified."—*Mr. John Almack, of Beverley*, Jan. 17, 1858.

"I can only give my opinion on the state of the land after the operation, which I consider quite equal to two ploughings, and on some sorts of land equal to three ploughings."—*Mr. Abraham Lennard, of Burstwick Grange, Hull*, Jan. 16, 1858.

"Respecting the steam-cultivator, when working at Broadgate farm, I was very much pleased with the way in which the soil was pulverized, and left light, open, and porous. My friends and I thought the work equal to two ploughings, a dragging, and three or four harrowings, well worth 1*l.* per acre."—*Mr. Thomas Stephenson, of Broadgate, Beverley*, Jan. 20, 1858.

"I have seen the cultivator working at different times during the last two years; once on a stubble-field of strong clay land, during a wet season in the autumn of 1856. It pulverized and left the land open and free for the full action of the atmosphere, and lighter than if it had been dug by the spade or tilled by any other implement, and fully worth 20*s.* per acre. Again, on a lighter soil, in dry summer weather, the work was equally satisfactory, part of the land made excessively hard by being carted over being so pulverized and in such fine tilth as to be ready for sowing with any description of crop. The great advantage of the machine is its being so easily steered, and turning so short round that it is able to do the headlands without the assistance of any other implement. Another advantage is, that when the land is cultivated by the machine, it does not 'set to the sole in wet weather,' as it does when acted upon by ploughs and harrows."—*Mr. John Turner, of Beverley*, Jan. 25, 1858.

The principal objections against this machine are these:—the weight is no less than 10 tons, and no matter how broad may be the tires of the bearing-wheels, they sink into soft ground, not

only impeding the onward progress, but tending to damage very adhesive clay by their pressure; while the stirring up of land already tilled and lying fallow seems scarcely practicable, owing to the great amount of power that would be needed for mere locomotion. The other objection is, that the number of wheels, running-bearings, and working parts, makes the machine difficult and expensive to keep in order, as well as very costly in the first outlay. The economy, however, no less than the superiority of the tillage, has proved a great success; the amount of work done having been from 4 to 7 acres a day, according to the description of soil and depth of work, at a total estimated expense of 5*s.* or 6*s.* up to 9*s.* or 10*s.* per acre, including 2 men, coal, water, &c., and 15 per cent. wear and tear, and interest for 200 days in the year, first cost being 800*l.*

An engine has been manufactured by Mr. W. H. Nash, of Cubitt Town, Isle of Dogs, London, in which the machinery is in certain respects simplified and improved. The digging-cylinder resembles the one already described, being made of quarter-inch plate-iron, though it is 8 feet wide, and of 2 feet 9 inches diameter, the tips of the cutters being 10 inches out from the cylinder, and so describing a circle of about 4½ feet diameter; but instead of having gudgeons working in plummer-blocks at the ends, it rotates upon trunnions or annular bearings of about 8 inches diameter. A shaft, driven by cranks and connecting-rods from the engine crank-shaft, passes through the centre of the cylinder, rotating however in the opposite direction; and at each end of this shaft, just within the cylinder, is an 8-inch pinion, which, by means of two intermediate pinions of rather larger size (supported by the framing through the trunnion or hollow bearing), drive an annular wheel (composed of four toothed segments) affixed to the inside of the cylinder. The movement is something like that of Barrett and Exall's Safety Horse-work, and is the same at both ends of the digger; the wheel-work being all boxed up within the cylinder, but accessible by the removal of portions of the plate-iron for the purpose. The engine crank-shaft is underneath the boiler, and passes through the hollow bearings of the main travelling-wheels on both sides the machine, this point being also the fulcrum upon which the lever-frame, supporting the digger, is allowed to rise and fall. But the next machine is proposed to be constructed with outside bevel-wheels, and shafting instead of the internal wheels and connecting-rods.

There is an arrangement of gear-work for driving either of the main carriage-wheels, or both, or disengaging either of them at pleasure; and, while there is a slow motion for use when cultivating, there is a faster speed of about two miles per hour for

travelling from place to place. The two 8-inch steam-cylinders (of 16-inch stroke) are placed underneath the smoke-box, like those of railway locomotives, and are fitted with reversing motion. The front pair of wheels are hung upon castors, the steerage being effected by controlling their swivel motion, or when turning short round with one of the large carriage-wheels as a centre, they are set entirely free to roll themselves in any direction. Screws, upon their supporting stems, are provided for adjusting the level of the boiler to inclinations of ground surface; and there is also a balance-beam connecting these stems, for dividing the weight equally upon each wheel, and allowing them to accommodate themselves to uneven land. The digger in its lever-frame is free to play up and down, according to the hollows or protuberances of the field, a small wheel at the end next the untilled land regulating the depth against fluctuations in the posture of the machine, so that, while the digger breaks or cuts up bricks, roots, &c., without injury, it rises over a very hard or immovable impediment, its weight being about 7 cwt. To lift it out of work, two hydraulic cylinders are provided, one on each side of the fore part of the machine, and steam being admitted, forces the pistons along the cylinders, and by means of chains pulls up the frame to the required height. Water is proposed to be used in place of the steam, which does not operate steadily or under such accurate control. The whole machine is about 18 feet in length and 10 feet wide, and weighs about 12 tons.

I saw it last November, at Royston in Cambridgeshire, working on a piece of mown stubble—a light, chalky, turnip soil, of a quality that turns sticky with wet, but dry and friable at that time. The main wheels of $6\frac{1}{2}$ feet in diameter, made with T iron spokes and plate-iron felloes 21 inches broad, sunk very considerably into this land, plainly showing the necessity for having flat platforms like those of the "endless railway" over which the heavily-weighted wheels might roll, but the difficulty of turning short round upon these "shoes" appears to be hardly overcome at present. The shares or cutters were arranged three in a row or ring, three successive cuts being made in one revolution of the cylinder, and the advance for each cut being about 6 inches. The digger made between 30 and 40 revolutions per minute, the engine running at from 120 to 160 strokes per minute, varying according to slight elevations and depressions in the ground.

The earth was well subdivided by the 33 cutters (that is 11 rows), and turned up in small spits, beautifully broken, much like spade work; the depth not exceeding 6 inches, or rather 6 inches at one end of the digger and 4 inches at the other, owing to want of rigidity in the lever framing. This it is proposed to remedy by

partly bearing up the end which is not supported by the small travelling-wheel, by means of the "hydraulic;" and this wheel also is to be placed exactly opposite the end of the digging cylinder, so as to adjust the depth of culture more accurately. In deeper tillage, the action of the machine is far more effective and economical, and it is able to dig 12 and even 16 inches deep. A length of 23 chains I saw cultivated in 23 minutes, including 1½ minute stopping, turning, and setting-in again; and as the breadth of work is 7 feet and a half, the extent dug in a day of 10 hours is nearly 7 acres. The engine working at 70 lbs. pressure may be called 20 horse-power, though it may be worked up to 80 or 90 lbs. if required, and hence the expenses may be estimated (with the same conditions as before, only that the price is 700*l.*) to be 6*s.* to 6*s.* 6*d.* per acre; and this is extraordinary economy when we consider the effective character of the tillage, and that work 10 or 12 inches deep would cost but little more,—that is, merely extra fuel for the greater power engaged.

Practical trial, then, has fully borne out the promise of theory: a rotary steam-cultivator *can* produce the most economical results, and possesses the greatest advantages, were it not that a further simplification of mechanism, and a relieving of the soil from excessive pressure, are still to be sought.

In August, 1857, Mr. Thomas Rickett, of the Castle Foundry, Buckingham, patented a steam-cultivator, in which a revolving tiller is attached to the tail of a locomotive engine; but, instead of taking advantage of its propelling action, this tiller is made to rotate in the opposite direction to the revolution of the carriage-wheels, thus tending to retard the progress of the machine and involving greater expenditure of power. The motion of the cutters is forward and upward, as in Mr. Paul's drain-cutter and subsoiler; and the earth is raised up in front of the axle, carried completely over it, and deposited behind by its own gravity. The advantage is, that the cutters are better able to cope with stony or very hard soils, and, entering the unmoved ground at the full depth, they avoid the difficulty of penetrating from the top when dry and baked with the sun. But this gain is found only in shallow working; as the hardest ground is certainly the pan or indurated stratum of subsoil underlying the staple at present cultivated, and which it is one of the main objects of a steam-tiller to break up. And a misapprehension as to the difficulty of penetration from the top arises from our experience of traction-grubbers, &c., which, with horse-power, have the line of draft considerably upward, tending to raise them out of the soil; or with steam-hauled rope dragging horizontally, the implement holds itself in the ground by the down-pointing of its shares, thus sticking well to its work with a rooting nose under a con-

siderable stratum of earth, but being liable to jump out from below a mere film. Rotary forkers, too, thrusting tines or spikes into the ground as they roll, experience a very different degree of difficulty in penetration to the revolving blades independently driven—in which the friction and pressure are on only one side or face of the blades.

In Mr. Rickett's machine the tiller axis must be very near the surface of the ground, in order to avoid lifting the soil higher than is necessary; hence it is placed as low as will allow room for the wheels, &c., for actuating it: but this arrangement involves the use of small motions, which cause excessive friction and wear. The machine exhibited at the Chester Meeting last year, and manufactured by the Castle Ironworks Company, consists of a locomotive engine with flue-and-tube boiler, 5 feet 3 in. long, mounted upon a framework, and travelling on four carriage-wheels, the two main wheels being of 4 feet diameter, with 12-inch broad tires, and the fore pair being used for steerage. It has double cylinders placed in the smoke-box, with the crank-shaft placed above the boiler, as in common portable engines; and the propulsion forward is effected by means of reducing toothed gear-work engaging with cage teeth on the inside of one of the travelling wheels. An endless pitch-chain from a pinion on the end of the crank-shaft drives a wheel of double the diameter upon a shaft placed underneath and across the back of the machine. Behind this shaft, and parallel with it, the digger-shaft is hung in two radial links or arms, which allow it to be raised or lowered, motion being communicated from the main shaft by a couple of endless pitch-chains, one at each end, passing round pinions upon the two shafts. These pinions are only 5 inches in diameter; while, to allow a depth of some 8 inches, the circle described by the points of the cutters is about 2 feet in diameter; the pinions and chains having thus to bear a tremendous strain, which would be still more severe in case of the chains wearing to unequal lengths; and driving by pitch-chains is objectionable, because of the friction and wear. The digger-shaft is about $2\frac{1}{4}$ inches square, and about 7 feet long; and the cutters, made two on a boss, opposite each other, are attached or removed by being slid along the shaft, the naves or bosses being so formed inside that they may be set in the right position for securing a helical arrangement of the cutters, in order that they may strike the ground successively, like the different parts of a screw-blade. And the cutters are curved arms, carrying either $2\frac{1}{2}$-inch prongs, or 5-inch wide, square-set, spud-shaped shares, of chilled cast-iron, or blades of an angular form, 7 inches broad, trucking each other, and so making two continuous screw-threads or blades, each spiral wrapping once round.

The tines are used for roughly breaking up without inverting: to produce partial inversion they are placed in pairs or triads together. To give more general inversion, the spade-form shares are used, moving the subsoil and inverting the sod, and leaving the roots exposed; while for wet clay land, angular cutters or shares are used; and for light soil, the broad shares, inverting the whole. The digging shaft is quickly lifted or depressed by screws, bevelled wheels, and a crank for the purpose. The speeds of revolution and progression are so timed that the engine advances 9 inches for each revolution of the digger; and there being two cutters in one circle at opposite diameters, each cutter takes a forward bite of 4½ inches. But this may be varied by changing a spur-wheel and pinion in the propelling gear for others.* In the trials the speed of the digger ranged from 60 to more than 80 revolutions per minute; the rate of travelling, therefore, varying from about half a mile to about two-thirds of a mile per hour.

The engine is of 8-horse nominal power, having two 5½-inch cylinders of 10-inch stroke; but being worked up to 90 lbs., and even 95 lbs. pressure, and making 140 to 150, and sometimes up to 180 revolutions per minute, was evidently giving off more than double that power. The digger-shaft being 7 feet in length, this breadth of ground was sliced up and broken to pieces to a depth of 5 or 6 inches, the knives dipping rather unequally (owing to the ground being in awkward ridges and furrows), and sometimes the digging was lowered to 7 or 8 inches. The narrow tines, with spaces between, tore up the soil into small fragments; the 5-inch broad spades (of which there were 24—two on opposite arms of the 12 bosses) cut the ground into curved wedge-shaped spits, and, turning them over the shaft, delivered them loosely broken, and mostly in an inverted position, with the soil well exposed.

The frequent stoppages, owing to the new and untested mechanical details, rendered continuous work impossible; but, from observations of a few minutes' operation at a time, the rate of advance appeared to be as already stated,—equivalent to 4½ to nearly 6 acres in 10 hours, or less when the time for turning at the ends is deducted. The expense, including 15 per cent. wear and tear, and interest on 440*l.* for 200 days in a year, would probably be from 7*s.* to 9*s.* per acre. The length of the machine is about 13 feet, and the weight when in work about 6 tons, which on that light, dry, lea ground, sunk the wheels very considerably into the ground, and would be very objectionable on wet clay.

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* *See* an engraving of this machine in the Report on Implements at Chester.—Journal, vol. xix., p. 321, 322.

I consider the principle less advantageous than that of driving the digging shaft or cylinder in the same direction as that in which the travelling wheels revolve, because the power required is greater, and the small diameter of digger which is necessary is open to these objections,—it incurs a very defective mode of communicating power through small motions; and this loss of power, added to the clogging with earth and weeds on light sandy loam abounding with couch-grass, such as the trial-ground at Chester, renders it unlikely that the digger could be worked with advantage in stiff soil. However, this was but a trial engine; and Mr. Rickett having cultivated with it up and down a hill with a gradient of 1 in 7 without difficulty, and considering the experiments successful as a first essay, is now building a more complete and capable machine. In communications accompanying drawings with which he has favoured me, he says:—

"I can hardly consider my present arrangements improvements upon the one you saw at Chester, as in that case the cultivator was adapted to an engine as an experiment, the successful issue of which led me in the next place to adapt the engine to the cultivator, or to design a machine specially for locomotive steam cultivation. Such an engine I am now building; it is 15-horse power, and will cultivate at least 1 acre per hour 10 inches deep. The cultivator shaft is driven by coupling-rods direct from the engine crank-shaft, both the shafts making 60 revolutions per minute, and the engine having a 22-inch stroke. This is the minimum speed, a much greater velocity being practicable when not inverting. There is an arrangement of land wheels to maintain always a uniform depth of digging, and only two men are required to work the machine. But the point to which I mainly directed my attention was that of providing an extended bearing surface on the land, believing that, although there are times when rolling wheels do not materially compress the land, generally speaking their effect is injurious. I sought, in fact, to bury the only real objection that can be raised to direct action. I patented last autumn a plan of 'elastic roadway,' by which I distribute the weight of the engine over 4 to 5 square feet, and therefore reduce the pressure on the land to about that of a man's foot. The price of this engine will be about 600*l*. I propose using 18-inch tines in this cultivator, the diameter of the circle they describe being 3 feet; and two cuts in each revolution, of 10 inches each. The width is 7 feet 6 inches. In September last I worked up and down a stubble field, gradient 1 in 7, when there had been rain on three previous days. Of course it was useless working, but we did not slip except in turning at the land's end, the tines in some places cutting through without bringing up the soil. Were it desirable to work land in such a state, I should use the angular spade form, which will cut wet clay; but I do not think it is, and I arrange now for breaking up the land in a dry state, without caring to invert,—though, of course, that can be done if preferred. I consider the upward cut advantageous, because cutting in the direction of progressive motion secures (from a combination of the two motions) a true and easy cut or cleavage; while it enters the soil or commences work where the ground is soft, with a light cut, which increases as it approaches the surface, where the hard-baked sod cleaves easily, being without support. But if you attempt, in a contrary direction, to break out a piece 10 inches wide, very considerable power is expended in compressing the soil before the action of the wedge is sufficient to sever the piece. In a

downward cut there must ever be constant compression of the soil, which is manifestly a waste of power, and injurious to the land. Again, in case of roots or large stones, when cutting upwards, they are lifted out with the superincumbent earth; but if downwards, something must break, or the machine be lifted out."

Mr. Rickett's reasoning on behalf of his very ingenious cultivator certainly holds good with respect to circles of such small diameters as are described by his cutters; but taking a diameter of 6 or more feet, which I hope to show the merit of at some future time, it will be seen that as the cutters enter the ground in a slanting direction, nearer to the horizontal than to the vertical, the objections as to compression, more difficult cleavage, and obstruction of stones, assume a very different aspect. And it will also be found that rotation against the onward movement of the machine involves a great waste of power, while revolution in the same direction as that of the travelling-wheels tends to propel the engine, and thus economises motive-force. Respecting the importance of adapting a steam-cultivator to our present agricultural engines, which I am of opinion is a momentous matter in securing the commercial success of such an invention, Mr. Rickett says:—

"I cannot admit the policy of considering existing implements or engines in the application of steam-power to the culture of the soil. The subject is of so much importance, that I think the best application and most economical in working should be studied, regardless of anything else; besides which, there will surely be as much work for the stock of portable engines to do as there ever has been. I hope to have a share of public patronage when my machine is practically perfect, but have no anticipation of any one system becoming universal. I love simplicity and direct action, abhorring wire-rope and other cumbrous tackle."

I have alluded to the impracticability of working a locomotive engine up and down fields where the surface presents abrupt inclines. In such cases—though less extensive and important than those of lands lying level enough for the purpose—either wire-rope traction must be resorted to, or, if found to answer, a travelling machine working a rotary digger may be actuated by an endless rope from a stationary engine. Mr. Atkins, of Chepstow, attempted this first in the year 1843, and, after more than two years' efforts, he succeeded in bringing out a model, worked under a patent taken out by Mr. J. A. Atzlar, of America, which model was exhibited at the Shrewsbury Meeting in 1845, though not in the showyard. A full-sized machine was constructed, and put in operation at Blackthorn, near Bicester, in Oxfordshire. In August, 1853, and again in February, 1854, this invention received provisional protection under the patent law. An endless rope is passed round a grooved wheel in connexion with the prime mover, or steam-engine, and, at the requisite distance,

round the pulley-wheels of a "rope-carrier," in which a weighted pulley, rising and falling according to the fluctuations in the tension of the rope, secures a steady strain for enabling power to be communicated to a travelling carriage, on which the rotary digger is placed. The engine and rope-carrier could be moved at intervals, as the work proceeded, by means of temporary wooden trams, or the engine might be kept stationary. The locomotive cultivating-carriage had a cylinder, with one or more smaller ones attached, these cylinders being studded with spades, knives, prongs, or teeth, as required; and the operations contemplated included "cultivating, sowing, reaping, mowing, dressing, ploughing, or other work required in agricultural business."

Mr. Atkins stated at the Society of Arts, in February, 1856, that the space between the carriage and the engine might vary from 50 to 1500 yards, thus enabling the machine or rotary cultivator to work up and down the land without any obstruction: a thousand yards of land might be cultivated with 10 cwt. of rope, with a 20 or 25-horse power engine, and the arrangement would be found of a most simple and inexpensive character. At the Birmingham Meeting of the Institution of Mechanical Engineers, in April, 1857, Mr. Atkins described his cultivating tool as having rotating forks or spikes, breaking up and loosening the soil. He considered the best mode of propelling the machine would be "to have a large fixed engine of 20 or even 30-horse power, set down in the centre of a farm; driving, by means of endless wire-ropes, extending to a great distance, and working at a high speed, so as to diminish the weight of rope required, the rope being carried on standards at some height from the ground, like a colliery-rope. This idea had been early suggested to him by seeing a rope-manufactory at Bristol, where a rope of two miles length had been working constantly for two years, taking the power from a 10-horse engine, and driving various machines all down the walk for a mile distance."

The method patented by Messrs. Fisken in July, 1855, of propelling a travelling windlass and attached implements by means of rapidly-running endless hemp rope and a fixed wire-rope, is specially adapted for driving a rotary digger in situations where the steepness of the fields precludes the employment of a locomotive engine. In June, 1856, Mr. Robert Roger, the manufacturer of Messrs. Fisken's apparatus shown at the Carlisle Meeting, patented a mode of actuating a spiked roller or revolving digger by a pinion and chain-wheel, set in motion by the spur-wheel attached to the winding-drums; and also another plan for adapting the fixed windlass system to work a similar travelling machine, with rotary cultivator, by direct hauling

For my own part, I see no difficulty in mounting a common portable engine crosswise upon a low truck, and its being made to drag itself slowly along the headland, the engine thus advancing sideways, always opposite the line of work. An endless cord or small wire-rope round a grooved rigger on the fly-wheel might transmit motion to the travelling digging-machine, and the cord or rope be held many feet aloft upon stands with friction-rollers. For getting a sufficient grip of the small light rope, Mr. Fowler's drum-grooves suggest a ready method.

In this rather lengthy section of the paper I have endeavoured to point out the advantages to be looked for in a direct-acting rotary cultivating-machine, the difficulties in the way of applying the motive power, and the attempts made at practical realization of what is simplest and most effective in principle. With so much evidence in its favour, and so much mechanical and agricultural intellect at work upon it, the revolving steam-digger has now every prospect of vanquishing all obstacles and entering upon a career of success.

I now come to describe our present attainments in

Machinery working Traction Implements.

Under this head my remarks shall be very brief; as *results* are of far more importance than the mere mechanical details of apparatus already well known, or previously described in the Journal.*

The Steam Ploughing and Cultivating Machinery of Mr. John Fowler, of 28, Cornhill, London, consists (as the reader is of course aware) of a combined engine and hauling drum at one end of the field, and a self-propelling perpetual anchor and pulley at the other; both moving slowly along the headland, so as to be always opposite to the work, while the plough traverses up and down the land between them, being pulled by an endless wire rope.† Instead of coiling upon a barrel, the rope is gripped by passing round grooves on a drum; and this method of hauling the rope has been attended with the best results; for the speed of the implement and the strain on the rope being thus steady and equal, the rope is able to bear a heavier load than when subject to the jerking motion of winding upon its own irregular coils. And as no reserve of rope is required upon the barrel, and the two plies run parallel across the field, the quantity of rope re-

* I must apologise to the various inventors for the hasty manner in which their machinery is described in this section of my essay: a sudden infliction of illness having prevented me from adding fuller details.

† See engravings of this apparatus in the Report on Implements at Chester, Journal, vol. xix., p. 325.

quired for any length of furrow is the shortest possible. The grooved drum with vertical axis is placed underneath the boiler, by means of a wonderfully light bracket framing, and is driven by toothed gearing and an upright shaft from the engine crank-shaft. There are also two pulleys, one at each end of the boiler; and the rope is so led round the drum and pulleys as to make two three-quarter turns round the drum; which is found to be quite sufficient to prevent the rope slipping though pulling with the whole force of a ten or twelve-horse engine. In case of the implement striking upon a rock, or other firm obstacle, however, the rope will slip in the grooves, and thus prevent breakage. The whole additional weight to the engine is only about 15 cwt.

The plough consists of two sets of plough-bodies attached to a long beam-frame, the set at one end pointing towards the set at the other end, and all balanced upon a central axletree and pair of large wheels. The ploughman rides upon the tail of the implement, steering accurately by altering the "lock" of the main wheels with a worm-and-rack motion. On arriving at the end of the furrow, the implement is made ready for the back journey, without being turned round, simply by pulling down the end of the frame which was in the air, and then directing the course of the plough into the next line of work. The wooden beams are so made as to be adjusted to any breadth of furrow, and the ploughs on either side can be raised or lowered at pleasure. For subsoil trenching the Cotgreave irons are added, which bring up the subsoil and lay it upon the furrow-slice. The same implement serves as a scarifier, by removing the ploughs and attaching a light frame to the beams, fitted with grubbing-tines. Also by taking off the breasts from the plough, leaving the ploughshares on, and adding a short blunt breast (or sham mould-board) to each share, and setting the coulter to cut the middle of the furrow-slice, a wonderfully effective scarifier is made. The whole of the land is cut with a perfectly level bottom, and the broken soil is lifted and lightened up in the best manner possible. Mr. Fowler has also a lighter and cheaper form of cultivator, not balanced or double-acting, but made to turn round at the ends of the field, this action being accomplished by the pulling of the rope, though by a different contrivance from that known as the Woolston "turning-bow." The implements carry a short reserve of rope, and means of adjusting the quantity of rope to any varying length of furrow. The engine is fitted with a pitch-chain and the requisite gear (Mr. Williams's patent) for propelling itself from field to field, or along common roads, with only one or two horses in the shafts to steer; and on hilly farms the hind axle can be raised or lowered, to preserve the level of the boiler.

The prices range as follows:—

	£	s.	d.
Eight-horse engine (single cylinder), with reversing gear, windlass, water-tub, anchor, 700 yards steel rope, headland ropes, 16 rope-porters, 2 snatch-blocks, and field-tools	455	10	0
Two-furrow plough (adjustable to any width of furrow), with scarifier irons	52	10	0
	508	0	0
Twelve-horse double cylinder engine, 800 yards of rope, &c., and four-furrow plough	780	0	0

And intermediate prices for eight-horse double-cylinder engine with three-furrow plough, and ten-horse engine with four-furrow plough.

The windlass gear is purposely constructed so as to be added to any ordinary portable engine. To work the machine are required one engineer, one ploughman, and two boys to shift the rope-porters.

The numerous and prolonged trials of Mr. Fowler's machinery have shown that heavy land can be ploughed by steam at the rate of five acres a day, for a total cost of seven to ten shillings per acre; and that light or mixed soils can be ploughed at the rate of seven acres a day, for about five shillings per acre. The work is done in admirable style, of course being all one-way, or turnwrest ploughing. The trenching implement turns up the ground 12 to 14 inches deep, inverting and sub-dividing with all the perfection of spade-husbandry. The recent improvements in the construction of the apparatus have materially reduced the expenses below even the above figures, and the scarifying or cultivating is performed at a still more expeditious and economical rate.

Ten sets of Mr. Fowler's steam plough have been supplied to the following parties:—

Mr. T. H. Redman, of Overtown, Swindon, Wilts.
Mr. J. H. Langston, of Sarsden Lodge Farm, Chipping Norton, Oxon.
Mr. E. Holland, of Dumbleton, Evesham, Oxon.
Mr. Lyne Stephens, of Lynford Hall, Brandon, Norfolk.
Mr. Collinson Hall, of Princesgate, Romford, Essex.
Mr. John Smith, of Coven, near Wolverhampton, Staffordshire.
Mr. S. Gurney, of Leatherhead, Surrey.
Mr. E. H. Gurney, of Red Hill, Reigate, Surrey.
Mr. Thomas Aveling, of Rochester, Kent.
Mr. J. L. Morton, of Murray Farm, Dalkeith, Scotland.

And twenty-five other sets are to be delivered in August, 1859.

Mr. Williams, of Baydon, Wilts, has the credit of having made some of the earliest experiments in steam-cultivation, and patented the mode of hauling with wire-ropes by a portable windlass, attached, when required, to a portable engine, both shifting

together along the headland opposite to the ploughing. He has also patented the very simple contrivance of a pitch-chain wheel-and-pinion, for making engines self-propelling. His implements consist of ploughs or of grubber-tines, suspended with independent lever motion in frames upon wheels, and have proved themselves to be very effective. Mr. Williams's hilly farm is being remodelled, fences straightened, water-tanks constructed, woods grubbed up, &c., so as to adapt it in every way to the new motive power, and facilitate every operation of the steam-engine in the field. For several years past he has ploughed, scarified, &c., with the engines used for thrashing; and he also employs the steam windlass in felling timber, extracting tree-roots, and displacing boulders and rocks with great power and expedition.

The apparatus of Mr. Smith, of Woolston, Bucks, as manufactured by Messrs. J. and F. Howard, of Bedford, consists of an engine, separate windlass upon travelling wheels, anchors, snatch-blocks, ropes, rollers, cultivators of different sizes, a double-breasted trench-plough, and subsoiler.

I need not enter here into a description of the mode of laying out the ropes, alternately winding up one and paying out the other, the method of steering the implement and turning it at the ends of the work, removing and setting down the anchors, &c.

The ropes inclose the land to be scuffled or "smashed up," not quite rectangularly, however, but passing round two fixed and two moveable snatch-blocks, so arranged as to cut off one corner of the plot.* The hands required are—one engineer, one windlass-man, one ploughman, two anchor-men, and one boy to shift the rollers. The windlass is driven with a belt by any common portable engine of seven-horse, eight-horse, or greater power. The price is—

	£	s.	d.
Eight-horse (single cylinder) engine, windlass, 8 iron anchors, 2 wood anchors, 6 snatch-blocks, 30 rollers, 3 wood levers, 2 beetles, and 2 crow-bars	340	0	0
1400 yards of steel rope	60	0	0
No. 3 implement	16	0	0
Turning-bow	21	0	0
	437	0	0

Additional charges are made for a wider grubber and for a very effective trenching implement.

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* See engraving in the Report on the Implements at Chester, Journal, vol. xix., p. 327.

The quantity of work done, the cost and character of the operations, &c., are comprised under the last section of this essay.

Messrs. Chandler and Oliver, of Hatfield, have an important modification of the stationary engine and windlass arrangement. They lengthen the hind axletree of a portable engine, and hang the winding drums upon it, one on each side the boiler, driving the drums by toothed gearing from the engine crank-shaft. By this means the separate windlass is dispensed with, and the driving strap avoided; but the engine is of course converted into a somewhat cumbrous and heavy piece of machinery. Instead of being placed in one corner of the plot to be ploughed, the engine is stationed midway down one side; and the two ropes, led round a double snatch-block set a few yards from the drums, diverge at an angle to the anchored snatch-blocks at the ends of the work. A shorter length of rope is needed than on the rectangular method of laying out; but four pulleys (or snatch-blocks) are required. The anchors and rope-porters used are similar to Mr. Smith's. The plough bears some resemblance to Mr. Fowler's; one set of plough-bodies pointing towards the other set; but instead of being attached to beams balanced upon a central axle and pair of wheels, the ploughs are so hung within a frame on three wheels, that one set can be raised and the other simultaneously lowered by a rack-and-pinion motion. The steerage is effected by levers and rods which alter the direction of the foremost wheel—made with an indenting edge to cut into the ground, and carried on a swivel. By combining the windlass with the engine the labour required is reduced to the extent of one man (needed to attend a separate windlass), but as the engine is not stationed at the corner of the plot of ground, the work cannot be crossed with the scarifier without shifting the engine, which is an important consideration. The plough is manufactured by Messrs. Howard, of Bedford, and I have seen it make some very good work.

Mr. Hayes, of Stony Stratford, has a windlass in which the two drums are driven from riggers placed on the frame between them: the drums being thrown in or out of gear by simply shifting the engine-belt from one rigger to another; and when both drums are out of work the belt is carried by a slack or dead rigger so that the engine may keep running.

Mr. Massey, of Newport, Salop, has added a traversing guide to the windlass, for adjusting the coils of rope, and thus dispenses with the manual labour hitherto necessary to superintend it. The eye or guide traverses to and fro by means of a double screw, after the principle of the Scandinavian printing-press.

Messrs. Howard, of Bedford, have also constructed a new windlass, with drums on vertical axes, and self-winding mechanism

for laying on the coils of rope. The motion being ingeniously adapted from the endless rack of Baker's patent mangle.

Messrs. Fisken's steam-ploughing mechanism, exhibited at Carlisle in 1855, is not now before the public in a practical form. The travelling windlass and rapid hemp cord have given way to the present wire-rope direct hauling; but I have already referred to the suitability of their plan for driving a rotary digger.

I can only allude in a word to the employment of traction or locomotive engines in cultivation; as, notwithstanding the many experiments and great performances of Mr. Boydell's engine, Messrs. Tuxford's, and also of Mr. Blackburn's and Mr. Bray's engines, I believe that these ponderous machines are beginning to take their true place on the road or on the farm as steam-horses for carriage rather than tillage. On very level lands and with great improvement in the working parts, perhaps they may be able to travel and drag implements behind at a comparatively cheap cost. In Cuba, I believe, Messrs. Tuxford's Boydell engines have given satisfaction; and certainly Mr. Burrell's Boydell engines have during the last few years hauled ploughs and cultivators with immense power, and in some cases made excellent work. As locomotives on common roads, these inventions are treated of in the next part of this paper.

This essay would be incomplete without a reference to the 'Guideway Steam Agriculture' of Mr. P. A. Halkett, of the Wyndham Club, and 80, Chancery Lane, London:—

This system of cultivation, by which the whole series of the operations of agriculture have been performed by steam power, consists in laying down, at intervals of fifty feet or more, permanent and parallel guideways or rails, by which a locomotive cultivator, carrying the motive power, is supported and guided, and to the under-side of which are attached the various implements to be used. On the headlands are other rails at right angles to the former, upon which a shunting or traversing carriage moves, by which means the cultivator is transferred from one set of rails to another, or is brought to the homestead where the engines can be used for thrashing or other barn operations. In this so-called guideway system of agriculture, there being no weight bearing on the land, culture can be performed in any weather and state of the ground without injury, even on the heaviest clay soil, leaving it in a state of lightness impossible to arrive at, where the weight of men, implements, horses, or tractive power is constantly consolidating or poaching it; whilst, by consecutive ploughings in the same furrow, it can be cultivated to a depth hitherto unattainable, except by the costly operation of deep spade trenching; and fresh soil to the

exact quantity required may be brought up and intermixed with the top soil. The crops are carried off and the manure carried on to the land with the greatest facility and advantage.

The quantity that can be ploughed per day with power suitable to a farm of 1000 acres, is 25 acres, and three men are all that are required to conduct the operation. This calculation, it must be understood, is based upon work which has been repeatedly performed. And, moreover, when time presses, by a change of men, double this amount, namely 50 acres, may be done in the 24 hours, because the operation can be carried on by night as well as by day. The great advantage of being able thus to break up the land in favourable weather, or for a rapid autumnal cultivation, can hardly be overestimated. This great economy of time is also available for reaping and carrying the crops in harvest.

The rails, forming a guide to the implements, insure that every successive operation shall follow in the same line, or parallel to it. Rows of plants have been drilled by the steam machinery, and, when up, have been hoed repeatedly by the same machine with the greatest perfection, and at all stages of their growth. In fact, hoes can be, and have been, placed so as to cut within half an inch of the plants in hoeing them, without injury in any single instance.

The whole cost of the system may be divided into—1. Annual rent of the rails, which, according to the inventor's calculation, may be put down at not exceeding 1*l.* 4*s.* per acre per annum for a farm of 700 or 1000 acres, or 1*l.* 10*s.* for market-garden land, near London. 2. The interest, and wear and tear of the engines and implements, which may be set off against the same for horses and horse implements. And 3. The cost of working the same (which is subjoined) will be found to be not one quarter of the cost of the same by horse power.

Cost of the Guideway or Rails.

In creosoted timber, 10*l.* per acre.
In hard burned brick and angle iron, 20*l.* per acre.

Cost of the operations for a Farm of 600 *or* 1000 *acres.*

Ploughing 5 in. by 10 furrows (twelve ploughs have been used, turning over twelve furrows simultaneously), 1*s.* 7*d.* per acre.
Hoeing (150 acres could be done per day), 3*d.* per acre.
Scarifying, grubbing, &c., 8*d.* per acre.
Harrowing, clod crushing, rolling, 5*d.* per acre.
Drilling or dibbling seed, 5*d.* per acre.
Reaping (cutting and delivering) at 60 acres per day, 8*d.* per acre.

Underground watering crops at the rate of 3000 gallons per acre, and 60 acres per day or night, or double this quantity if done by night and day, 1*s.* per acre.

Surface water (with hoes following), 1*s.* 2*d.* per acre.

Carriage of manures on to and distributed over land, and of crops carried off, also carriage of marl, clay, sand, &c., ½*d.* per ton per mile.

The amount that can be carted at a time, for either water or manures, &c., 70 tons.

Deep cultivation, to the depth of 25 in. (explained below), 12*s.* per acre.

The operation of "underground watering" consists in supplying to the roots of the crops, while at the same time the ground is stirred and hoed, water (or liquid manure), by drawing hollow bars or coulters between the rows of the plants, at the bottom of which the liquid escapes at any desired depth. By this means the fluid is economised on account of the evaporation from the surface being prevented; and it does not cake the soil, which agriculturists object to as the result of the usual practice of watering; nor draw the roots to the surface in search of the moisture, afterwards to be injured by the parching of the ground. This operation has the warm approval of all the market gardeners who have seen it.

The deep cultivation was performed, by first using six ploughs, cutting six furrows simultaneously of five inches depth; then ploughing again to a further depth of five inches; and at fifteen inches below, through the subsoil of a hard yellow clay, an anchor was drawn, with a palm of nine inches width; thus ploughing and breaking up the ground to a depth of 25 inches. This is a depth of cultivation sometimes attained by market gardeners by trenching, and would cost 10*l.* or 12*l.* per acre.

This advanced mode of steam husbandry is likely to have a trial on a scale of sufficient magnitude: meanwhile I can only refer to a proposition for the expenditure of 20*l.* per acre in rails above ground, after an outlay of several pounds per acre in drain-pipes below, as the greatest step yet taken towards exalting the farm into a manufactory, with a marvellous increase of its productive capability, and a hitherto unknown sureness and certainty of crops.

Locomotives for Farms and Common Roads.

The history of locomotive steam-engines for travelling on common roads would prove too voluminous a topic for these pages; but as many minds are now busy in solving the problem how to make the farmer's engine almost, if not altogether, independent of his team for journeying with its tilling-machinery

from field to field, or with its threshing-mill from farm to farm, I must look back to the gradual nature of the steps by which the object has been so nearly, if not completely, attained. In the year 1841, a *portable* steam-engine was first exhibited as "the great novelty," at the Society's Show held at Liverpool, though others may have been in use before that time. At Bristol, the next year, the same engine was shown, with additional mechanism, by which it propelled itself, and was readily steered in any direction over uneven ground. There were also two portable engines by other makers. At Derby, in 1843, three portable engines were present, and steam-engines there figured for the first time as a class in the prize-list. At Shrewsbury, in 1845, there were only two; at Newcastle, in 1846, only one portable engine. The succeeding meetings showed a continual increase until 1851, ten years after the first was exhibited, when the number of portable threshing engines in the kingdom was computed at 8000, and the multiplication has proceeded at a far more rapid rate since that period. Of course, it is not possible to ascertain every instance of attempted locomotion of an agricultural steam-engine, but the following are those with which I am acquainted. Though the engine was made locomotive at so early a period, the principle found little favour, and it is only very recently that we have ventured to trust our expensive motive-agents to propel themselves (with the added weight of water and fuel and steering-wheel) over rough roads, which we find they are quite strong enough to do, dragging a load at the same time. In 1851, Mr. Usher's steam-cultivator, weighing $6\frac{1}{2}$ tons, travelled 5 miles to a trial-field and 5 miles back, along a common road, and passed to and fro over the surface of fields, doing some very rough work, without the jolting causing any injury to the machinery or boiler.

I need not enter into the history of the traction-engine, fitted with Mr. James Boydell's "endless rails" (patented in August, 1846, and February, 1854), which has excited so much attention ever since the Carlisle Meeting; but shall refer to some of its performances. Rail-pieces hang upon the circumference of its carriage-wheels, fitting each to the other as they successively form the feet of the wheel in its revolution, so as to produce a continuous line of rail over which it revolves. They bridge over hollows and lay inclines over eminences, thus averaging a comparatively level line of roadway. The mechanical advantage upon soft ground is obvious from a mere consideration of the difference between bearing the weight of the carriage upon the convex periphery of a broad wheel and bearing it upon a flat platform like a "shoe," or rail-piece of similar breadth. Theoretically, a wheel-tire touches the ground so that its surface of contact forms only a mathematical "line," and it must sink into the

ground in order to get a bearing superficies at all, this superficies being greater the deeper the wheel sinks in; but the rail-piece always bears with a large superficies upon the ground, so that no matter what weight may be upon it, it is pressed into the ground very slightly indeed. The traction-engine will accordingly travel over soft and marshy soil, or where no roads exist. In the experiment before a Committee of the Board of Ordnance, the engine, with a sufficiency of water for a long yoking, weighing 9 tons, hauled a heavy siege-gun (5 tons 12 cwt.), carriage and tender (2 tons 7 cwt.), and 16 men (say 1 ton 5 cwt.), making a total of 18 tons, including the engine itself, from the Woolwich Arsenal up Burrage-road to Plumstead-common, and down the steep incline to Waterman's-field in return. The steepest part of the ascent is 1 in 10, and of the descent 1 in 8. In going up, the wheels of the gun-carriage sank 1 to 3 inches in the bare shingle of the road, but the engine was able to haul it, and could also stop in the steepest descent. But long journeys have been repeatedly taken, as well as great loads drawn along; the principal wear being in the rail-pieces and their attachments, and the consumption of oil and grease is very great, but without any special liability of damage to the engine itself. Mr. Charles Burrell, of St. Nicholas Iron-works, Thetford, Norfolk, manufacturer of the engines which have been often exhibited, has recently patented an improved method of affixing the "endless rail" to the wheels: the angular guide-piece is made to work through the rim of the wheel instead of being placed outside, and, with the rails and wearing-parts, is made of steel, thus obviating the excessive wear and tear which has been the chief objection to the invention.

Messrs. Tuxford and Sons, of Skirbeck Iron-works, Boston, have manufactured several traction-engines, fitted with the endless rails. These engines will take the most acute turns on common roads, describing a circle on an area 30 feet in diameter: they have also a remarkably neat friction-box arrangement, by which either side wheel can be instantaneously detached from connexion with the power, or either wheel thrown into gear, or a greater power given to one than to the other, without the least shock or jar. The weight, exclusive of water and fuel, varies from 12 tons upwards according to size. At Salisbury, and again at Chester, besides many other occasions, and in a journey from Thetford in Norfolk to London, Mr. Burrell's Boydell engine demonstrated its ability to ascend inclines of 1 in 10, and even 1 in 8, dragging a load after it, and to be readily guided in any direction and backed at will. The performances in cultivation I have alluded to in another part of this paper. Only let the item of wear and tear be improved upon, and the endless

rails will become invaluable for enabling the farmer's engine to draw his harvest home, lead out manure, and market his produce, and especially for bearing the ponderous burden of a massive engine over arable land, with little detriment to the tillage condition of the moist or clayey soil. The price of Mr. Burrell's engine, as exhibited at Chester, is 750*l.* to 800*l.*: Messrs. Tuxfords' prices vary from 550*l.*, the cost of an engine capable of working up to 20 horse-power, driven from one wheel only, up to 1020*l.*, the cost of an engine working up to 32 horse-power, and driven from both wheels, with disconnecting apparatus.

Mr. Burrell patented, in April, 1857, the application of the Boydell rails to common portable engines, driving one or both of the wheels by very simple mechanism. A single-cylinder traction-engine is thus made; and is steered and also assisted over abrupt ascents or obstacles by one horse in a pair of shafts. This combined arrangement removes in a great measure the liability to accidents incurred by horses passing a puffing engine and black smoking funnel on the high road. The engine is capable of drawing a threshing-machine, a set of ploughing or cultivating tackle, &c., over rough roads, or, indeed, where no roads exist. The first was exhibited at the Salisbury Meeting in 1857, and Mr. Burrell has sold two, which are now in work with itinerant threshing-machines, the horse-steerage answering its purpose very well indeed. He informs me that one of these engines has been in daily use for twelve months, without repairs of any consequence. The additional price of an engine so fitted, with plain wheels in front and a water-tank beneath the boiler, is about 140*l.*

Mr. J. A. Williams, of Baydon, Wilts, patented, in January, 1857, a remarkably simple way of making portable engines locomotive for purposes of steam-culture, consisting in attaching a chain-wheel to one of the hind carriage-wheels, a chain-pinion on one end of the crank-shaft, and passing an endless pitch-chain round them. Driving by a pitch-chain may not be the best mechanics; but, if wearing more than toothed wheels would do it, avoids having an intermediate motion or substituting larger carriage-wheels. At the Salisbury Meeting, two engines thus fitted displayed their travelling capabilities, with horses to steer, and they took themselves and their respective machines (consisting of windlasses and tenders combined, ploughing-frame, &c.) home, a distance of 40 miles, with the assistance of one horse to steer; carrying, in addition to the weight of the machinery, 100 gallons of water and half a ton of coal. Assistance from horses was required only at two hills, which were very long and steep.

In a letter to the *Mark Lane Express* of September 6th, 1858, Mr. Williams says: "On going to Mr. Owen's to work on his farm, two of my engines, with one horse in the shafts of each to steer, propelled themselves, and each took a ploughing-machine and a cultivator behind them, and the 7-horse one a small waggon in addition—two regular trains, Mr. Owen helping them up a steep hill near his house with two horses each; when, after ploughing for him and an adjoining farmer, the two horses and engines brought the whole of the tackle home, a distance in the whole of 20 miles!" In another letter of November 22nd, 1858, he writes: "I have three steam-engines of my own, and I have made them all locomotive. One of my engines has travelled not less than 160 miles on Her Majesty's highway; the second has moved over 100 miles of the same, and the third has rejoiced in moving about my own parish. . . . . . We have passed hundreds of horses on the road, and never met with but one restive one, the greater part of them taking no notice of the engine at all. . . . . . Horses have to pass the railway trains, and often wait at the gates whilst the engines are passing by: there is no doubt they will have to pass many an engine on the road, and the sooner they are broken in to it the better."

Mr. Williams's engines are Clayton and Shuttleworth's patent portable, with ordinary tubular boilers; and, notwithstanding all their up-hill and down-hill journeyings, he says that they have never yet leaked. It has been the practice to stop awhile before descending a hill, and pump an excess of water into the boiler, so that the fire-box top may not be exposed to the action of the flame without being in contact with water; and the consequent priming is not found to do any injury. It should be noted that these are single-cylinder engines, and that the difficulty of starting when the crank is at its dead pull is overcome by the horse applying his whole strength just for an instant.

Messrs. Garrett and Sons, of Saxmundham, Suffolk, showed at the Chester Meeting a double-cylinder 12-horse power portable engine, which drives one of its carriage-wheels by means of an endless pitch-chain, and is steered by a horse in shafts. It is also fitted with a break—an indispensable accessory, unless the engine be constructed with reversing-gear. There is a water-tank beneath the boiler, and a stage for coal and to serve for the driver's standing-place. Messrs. Garrett state that the self-propelling gear is intended to act as an auxiliary rather than to supersede the use of horses altogether for the purpose of transport; and that where it has been already employed for conveying engines and drawing machines let on hire from farm to farm, it has been found to be economical and to answer well. Their charge for this addition to an engine is 5*l.* per horse power.

Messrs. Clayton and Shuttleworth, of Lincoln, exhibited at the same meeting a 7-horse power single-cylinder engine, fitted with reversing link-motion, and toothed gear-work for imparting motion to the main travelling-wheels, which have plain tires. The steerage was effected by a single wheel turning in a transom in front; the price was 350*l.* But this steerage has been given up, and a pair of shafts substituted for a horse to guide, and also assist in starting and pulling up-hill.

Mr. Walker, of Terrington, near Lynn, Norfolk, has a traction-engine, manufactured by Mr. Savage of Lynn. It is a 7-horse power, single cylinder, portable engine, supported by a timber framing, and mounted midway upon a pair of carriage-wheels of eight feet diameter, with broad felloes, and one smaller wheel in front for steering turning in a transom. Both main wheels are driven by reducing toothed gear from the crank-shaft, and for turning curves or sharp corners either wheel can be disengaged at pleasure by a clutch formed with teeth so as to grip at any part of its revolution. Having no endless-rails, the wheels are liable to sink with the weight into miry roads or fresh-cultivated land, and traverse with disadvantage over rugged surfaces; but with angular projections of wood set round the tires to bite the ground and prevent skidding, the engine is able to draw implements in work as well as heavily-loaded vehicles. In that level marsh district, where there are no gradients but those of the bridges or approaches to crossings of railways or sea-embankments, this engine travels along ordinary roads at the pace of three or more miles per hour, dragging a threshing-machine from one farmstead to another, threshing corn as a stationary engine, and then conveying it in waggons to the market, sea-port, or railway, and carrying back coal, oilcake, timber, or manure. And this last season it is said to have prepared 120 acres of land for wheat-sowing with a Coleman's cultivator.

Mr. John Smith, of the Village Foundry, Coven, near Wolverhampton, has applied Mr. Williams's plan to portable engines, which travel without the addition of endless rails. He has manufactured three engines of the kind. The first was built in 1857, and used in working one of Mr. Williams's ploughs; this engine being placed on one headland, and a 10-horse single-cylinder engine, also made locomotive, on the other headland, and either of the engines used to take its own tackle, plough, and windlass with it to the field. The first has its water-tank on the top of the cylindrical part of the boiler; it has two 6-inch cylinders of 8-inch stroke, runs fast, and generally with a pressure of 80 lbs. to 100 lbs. pressure of steam. It used to draw the 6-furrow implement with greater ease than the 10-horse single-cylinder engine did. With it Mr. Smith has taken very con-

siderable weights along common roads, such as its own ploughing-tackle, and sometimes about 4 tons of coal on a common waggon. In October, 1857, Mr. Smith made a portable 6-horse locomotive engine for Messrs. S. and G. Lewis, of Audley, near Newcastle, Staffordshire, and the following is their account of its working :—

"Our locomotive threshing-engine gives us perfect satisfaction. The neighbourhood of Audley is very hilly ; and sometimes we have to go up, not only long, but steep hills, when the engine takes itself and machine, with one horse to guide it and help to draw. We do not find it difficult to go on the common roads, and make the usual turns, some of which are rather sudden. We find especial convenience in thus moving from place to place at times when persons are busy with their horses, or would object to take them out so late in the evening ; and as we can move in the evening after threshing our day's work, sometimes several miles, the engine has saved us the loss of many a day since we have had it. Indeed, we have threshed at two or three places in one day, and so saved much time in emptying and refilling the boiler, as we otherwise must have done. And then we consider that this engine will last longer than an ordinary one, as it is not so frequently subjected to sudden contraction on the tube-plates, as we do not need to empty it more than once a month. And, again, we think it travels better along the common roads than it would do without steam (the water and pressure in the boiler tending to relieve the tubes of the jar which they are subject to when the boiler is travelling empty over a jolting surface). We steam up in a few minutes ready for work, and as the convenience of our engine obtains for us an extra price of 5*s.* per day more than an ordinary engine, and gets us many customers which we should not otherwise have had, this must make a very considerable item of profit in the course of a year. We have had full work for it, when other engines for hire were long standing out of work."

In traversing alternate hills and hollows in quick succession, it appears that the tubes and fire-box of a boiler are not liable to any special injury—the momentary displacement of the level of the boiler not allowing time for the portions of heating-surface (left bare by the water) to become dangerously hot ; and when a slanting position occurs for a longer time together, upon moderate inclines, the "swill" of the water with the irregular motion of travelling seems to keep the exposed parts sufficiently cool. Of course, a boiler constructed with flues as well as tubes is less subject to damage than one in which tubes take the heated air and flame directly from the fire-box. To escape leakage, burning, or explosion, when the engine is required to stand for a long time together on the sloping headland of a field (as in working Fowler's plough in a hilly country), or in case of delay and detention upon a steep gradient, there must be either some means of adjusting the level of the boiler or the boiler must be of peculiar construction.

Mr. Smith has contrived an engine which can operate without detriment upon the steepest inclines that its power may enable it to climb, either by its own locomotive action or by the slower motion and stronger purchase of a barrel and

anchored rope, as in working Mr. Fowler's plough. A horizontal tubular boiler is mounted upon a wrought-iron framing, and balanced upon two plummer-blocks, so that it can be instantly and easily adjusted to any level by means of a screw under the command of the driver, who has a spirit-level to guide him. The cylinders are not fixed to the shell of the boiler, but are placed within the framing underneath it; the steam passing by a pipe from the top of the high steam-dome and through a stuffing-box in one of the plummer-block bearings upon which the boiler is suspended, while the exhaust steam is conducted to the chimney by a short piece of flexible pipe. The water is supplied to the boiler by the feed-pipe passing through a stuffing-box in the other plummer-block bearing. The hind-wheels (of 6 feet diameter with 12-inch broad felloes) are about 9 feet from the front wheels, which are of $3\frac{1}{2}$ feet diameter; so that a short depression or elevation in the ground makes but a slight alteration in the position of the boiler, and the balance-motion allows it to be adjusted so as to continue horizontal on inclines of 1 in 10. The propulsion is effected by an endless pitch-chain from a pinion on the crank-shaft (under the boiler, and supported in bearings on the frame) to a cog-wheel on the hind-wheel axle; each of these main travelling-wheels being set tight or loose on the axle by means of rings or "straps," which clasp like a break.

Another peculiarity is that the whole is supported upon strong springs, which, however, are taken out of action by a screw when required; and the weight, about 7 tons with water, &c., is so distributed that rather more than half rests upon the hind or driving-wheels. There are two cylinders of $8\frac{1}{4}$ inch diameter and 10 inch stroke, making 120 strokes per minute; the working pressure generally 60 lbs., but the boiler calculated to carry 120 lbs. pressure per square inch: thus, while nominally of 10-horse power, it works in reality at some 25 to 30-horse power. Over very imperfect roads, up gradients of greater steepness than even 1 in 10, the engine travels, dragging 6 or 7 tons' weight of ploughing machinery behind it, without having recourse to the "endless rails," though in some circumstances they would be advisable. A horse is used for steering with a pair of shafts. Respecting the cost, Mr. Smith writes me as follows:—

"My price for an 8-horse single-cylinder engine, constructed in the general way, with Lowmoor plates in fire-box, and copper piece to receive the tube at the fire-box end (a plan not generally used, but which, I feel assured, will be found a great advantage), is 215*l*. An 8-horse engine with double cylinders, 235*l*. Extra for making locomotive by means of Williams's pitch-chain, 25*l*. But these engines I could not recommend for ploughing purposes, on account of the wheels not being adapted to travel on loose headlands, when cultivating land. What I think would be best calculated for that and other general pur-

poses for which an 8-horse power would be sufficient, is an engine built with frame, water-tank, reversing gear link-motion, travelling-wheels 12 inches wide, and made locomotive with the pitch-chain, for 335*l.*; or if with my patent balanced boiler, &c., 360*l.* The 10-horse engine [described above] costs 420*l.*"

There is a simple method of overcoming the difficulty of a varying level of the boiler, namely, preventing "priming," in spite of a considerable depth of water above the fire-box, by taking the steam from the top of a very high steam-dome. Mr. Collinson Hall and Mr. Thomas Charlton patented in May, 1857, the engine of peculiar construction, worked at enormously high pressure, which appeared at the Salisbury Meeting; and they divide the steam-pipe, so as to take the steam from two domes, or from either at pleasure, so as always to get "dry" steam from the highest point, no matter what may be the position of the boiler. This engine is fitted with the Boydell rails, and was employed to drag implements behind, or propel them before, or at one side of it; but Mr. Hall has now adopted wire-rope culture, finding his engine answer every requirement as a locomotive along fields and common roads.

Locomotives are also being made for running at a rapid rate upon ordinary roads. A correspondent writes from Trentham, Staffordshire, January 25, 1859:—

"I have been working a little engine lately, made to carry three people (besides stoker behind): the machinery is under a ton, but with water and passengers, amounts to near 30 cwt. I have driven it 1 mile in 5 minutes, and 1 mile in 6 minutes average, for the hour together between here and Wolverton. Last week I drove it from Trentham to Lilleshall, in Shropshire, 26 miles, before 11 o'clock A.M.; consumption of coal 6 to 7 lbs. per mile. It requires a light engine, worked at a high pressure; with only 10 per cent. more weight we could not get up the hills. The great objection now is the danger of frightening horses; but I have run this little one upwards of 100 miles, and a 7-horse engine as many, without any accident, and believe horses would soon get accustomed to them if introduced."

There are several other locomotive portable engines, which I have not time now to describe: as that of Mr. Lee of Walsall, shown at the Salisbury Meeting, having Boydell rails attached, and propelling itself by a pinion on the crank-shaft gearing, with a spur-wheel fixed to one of the travelling wheels; that again which Mr. William Cambridge, of Market Lavington, Wilts, exhibited on the same occasion, made self-propelling by pinions and spur-wheels, driving its main carriage-wheels.

Mr. William Bray, of Folkestone, patented a traction-engine in December, 1856, in which blades are made to protrude radially from the periphery of the travelling-wheel to any extent required, and slide in and out by means of a fixed eccentric, so as

to clear themselves of soil, ready for penetrating and taking fresh hold of the ground. The trials with this engine have shown that it can draw implements with good effect, without the wheel being liable to "skid" or slip, and also pull great loads along ordinary roadways; the blades or projecting fingers being withdrawn at pleasure, by simply adjusting the position of the eccentric.

Mr. Blackburn, of Long Eaton, near Derby, has another form of engine, in which the weight is sustained by a large rolling cylinder, having the boiler and engine inside it. Messrs. Chaplin and Co., of Glasgow, exhibited at the Londonderry Meeting last year, an agricultural and self-propelling roadway engine, having an upright boiler mounted upon a frame running on three wheels, and very simply constructed. The boiler is made to consume the cheaper kinds of fuel, such as coal-dross, light wood, &c. The price of a 7-horse power, with double 6-inch cylinders, is 225*l.*

I have devoted a considerable amount of space to the numerous endeavours which are being made to perform the carriage-labour of the farm by the same engine that tills and thrashes; and, indeed, it may soon become common to "cart" as well as cultivate by steam-power, and so dispense with horses for all except, perhaps, the lightest operations.

Practical Experience.

"Cases in which steam-power has been employed in the ordinary cultivation of a farm," are now becoming rather numerous. I propose to notice only those which present examples of something more than experiment; and out of the number of farms upon which steam tillage is a regular part of the business-management, I have selected those which I have had an opportunity of personally inspecting.

As a fine example of the value of the Woolston system of steam-cultivation, I cannot do better than describe, first, the farm of Mr. Pike, of Stevington, about five miles from Bedford, on the Olney road. On the way from Bedford you pass heavy clay land on one side, and gravelly land on the other; then cross a range of hills with limestone cropping out, and find the farm at Stevington on the lias clay, having an abundance of sticky soil, and partial reaches of drift-clay or till, with pebbles intermingled. Mr. Pike's occupation, under the Duke of Bedford, comprises about 500 acres; the arable being about 350 acres, of which one-fourth, or 75 acres, is now in green-crop fallow every year. The fields are large; one being 50 acres in extent, another 40, and so on (one 35-acre boundary piece is three-quarters of a mile long). There are some rather steep slopes, with a good aspect; the general surface, however, lies well for steam-cultivation.

Having drained his farm with pipes laid 4 feet deep, Mr. Pike has been bold enough to level the ridges and furrows, with great advantage to his management, but with the fears and doubts of many practical critics, on this, some of the stiffest soil in the whole county. Certainly this step of levelling the surface, now proved in every strong-land district to be safe as well as beneficial, ought everywhere to precede and prepare for the advent of the steam-plough and the reaping-machine. With no water-furrows, Mr. Pike's land (with some steep declivities) has not had any water standing on it after a heavy twelve hours' rain. Without staying to describe the homestead, the arrangement of chaff-cutting, pulping machines, the useful meal-mill, &c. (driven with belts and fixed shafting by the same engine that cultivates and threshes), or the new houses erected purposely to shelter the steam field-machinery, I pass at once into the business of the fields, which I inspected early in February, 1859.

And here it should be noticed that while the hedges (clipped once, and often twice a year by covenant) are low and neat, and there are everywhere—whether in the sheep-fold upon fine turnips, in the regular wheat plant, and the clean deeply-upturned fallow—evidences of good husbandry, yet you meet with spots in which such weeds as wild onions indicate a natural poverty in the soil; the pastures produce a very inferior quality of herbage; and certain low portions of small extent are infested with couch-grass. Mr. Pike has only farmed here for a few years, and will, doubtless, master this tendency.

First, we find a 22-acre piece of vetches looking uncommonly well, though sown with only five pecks per acre. The field was a wheat stubble: 12 acres were steam-grubbed with the Woolston "three-tiner," and crossed with a horse-scarifier, then harrowed and drilled by horses; the other 10 acres were ploughed, &c., in the ordinary way, but no particular difference is at present observable. All the piece is free from weeds, with the exception of a few annuals, which the tares will quickly smother.

On 50 acres of wheat I observed everywhere a fine plant, slightly blue with the frosts, which, however, will prove beneficial rather than otherwise, by checking the upward growth. The higher portion of this field is after tares, and was broken up and crossed with the two steam implements; the lower part is after seeds, that is, ryegrass, trefoil, &c., sown on a fallow; and this was broken up and crossed by steam-power in the summer, and afterwards worked with a 5-horse scarifier; the five horses effecting about 3½ to 4 acres a day. All the wheat looks well, though put in without ploughing; little or no couch is to be seen, and but a few annuals, excepting a sprinkling of scratch-

burr or "clench." A strip of a few yards' breadth was ploughed by horses for the sake of comparison; but the only difference perceptible is in the rather less proportion of stubble or dead rubbish exposed upon the surface. A 29-acre piece of wheat, after beans, also looks well and clean, though sown without ploughing. The bean-stubble was torn up 6 inches deep by the three-tined steam-grubber, at the rate of 7 or 8 acres a day, and crossed with the broader implement, then, after a while, harrowed and drilled.

In another field, 32 acres of very heavy soil indeed, the upper half is barley, after a bean-stubble, grubbed by the steam-cultivator, and sown without ploughing; the lower part is a healthy plant of wheat, after a clover lea, ploughed with three horses in line. The adjoining field of 35 acres is fallow. The lower portion bare-fallowed for barley, received its first ploughing late in winter, or in early spring; this being 7 inches deep was very laborious work, as 5-inch ploughing is always done here with four horses. It has been ploughed five times, and had two scarifyings, all by horse-labour; the manure, about 15 loads per acre, is in the ground, and the next process will be simply harrowing and sowing the barley. This land is wet and amazingly sticky to the feet, forming a contrast with the similar soil of the last field, which, after the steam-grubbing and absence of trampling, is considerably more light, spongy, and porous, though, indeed, not so recently drained. The upper part of the fallow-break has produced (with superphosphate and guano) some good green round turnips and a proportion of swedes, which are being eaten on the ground by sheep. The portions of this folded land, already ploughed, have turned up in a tough, wet, and cohesive state, fit only for growing *quality* of barley without much yield; evidently it would have been in a lighter and better condition if broken up with the steam-cultivator.

I now come to 35 acres of fallow, in which the advantage of the steam-cultivator is most striking and wonderful: 15 acres of this field, in rather a foul condition after tares (being a low wet bottom, naturally "running to twitch," a small ineradicable variety), were steam-grubbed, and again crossed by steam, but unfortunately not until the latter end of November, so that there was not time to cleanse it: but the rubbish is left on the top ready for extraction and removal when dry weather arrives. The other 20 acres, however, have been brought into an admirable state in the cheapest and most effectual manner. The piece of wheat-stubble was grubbed and crossed by the steam-cultivator in the hot weather, and afterwards ridged up into drills or "stitches," about 27 inches wide, with a double breast-plough drawn by horses. It lies in a beauti-

ful state, very pulverulent and open, presenting the largest possible superficies to the influence of the atmosphere, and the land is certainly very clean. Farmyard muck will be spread in the open rows, artificial manure sown broadcast over all, and then the ridges will be split by the double-breast or bouting plough, and mangolds dibbled, which is Mr. Pike's practice. This ridging could be performed by the Woolston implement for the purpose. but two horses and man do 3 to 4 acres a day, and by changing two sets of horses (working half a day each pair), 4 to 6 acres, or even more, may be accomplished in a long day. With a 7-horse power engine, and latterly with a Clayton and Shuttleworth's double-cylinder 8-horse engine, Mr. Pike has done 5 to 7 acres a day of breaking-up with the three-tined implement, 6 to 8 inches deep, and 8 to 10 acres a day of crossing with the five-tined grubber: including the "shifts" and setting-down to fresh work, say 30 acres a week of the first and hardest operation. The area compassed, at one laying-out of the tackle, has been 10 acres or more, and 50 acres were embraced in four compartments, the engine and windlass working from only one station in the centre of the field.

The whole quantity of work done up to the time of my visit, is stated in the following letter to Messrs. J. and F. Howard, of Bedford, the manufacturers of the implements:—

"GENTLEMEN,—The Smith's steam-cultivating apparatus with which you supplied me in May last is now laid up for the winter, I am happy to say, in good order. In looking over the work I have done with it, I find that I have broken up 201 acres, and have crossed 128 acres (in all 329 acres). The cost per acre has varied according to circumstances, but I beg to say I am perfectly satisfied that it is not only much cheaper than horse-power, but much more effective, inasmuch as we can break up the land to a much greater depth, and the soil is also looser and moved more thoroughly, owing to the pace being so much faster than when horse-power is used. My land, as you are aware, is unusually strong; and now that you have strengthened those parts which we soon found were required stronger for this tenacious soil, I am satisfied that both the implements and the system are right for the strong land of this country, and must come into general use.

"I am yours truly,

"WILLIAM PIKE.

"P.S. I formerly worked fifteen horses, but have reduced them to eleven, and flatter myself I can do with nine."

This testimony is valuable, as being that of a practical business man (without any connexion with the manufacturers, and having no interest in the success of the invention), who spontaneously adopted the system from what he perceived of its merits, as exemplified at Woolston and elsewhere. No precise memoranda of expenses have been kept, but we estimate them somewhat as follows:—

Labour per week as per Mr. Pike's estimate :—

	£.	s.	d.	£.	s.	d.
1 Engineman	0	15	0			
1 Windlass	0	12	0			
2 Anchor men	1	0	0			
1 Ploughman	0	10	0			
1 Boy	0	6	0			
				3	3	0
Coal, 3 tons, and oil, &c.				3	0	0
Shifts, with horses, &c.				0	10	0
Water-carting (from a long distance—about a mile)				1	10	0
				£8	3	0

Wear and tear of tackle (not including the rope) and interest upon first cost, say 15 per cent. on 165*l*., reckoned on 20 weeks in the year, will be 1*l*. 4*s*. 9*d*.; wear and tear, etc., of engine, which is employed say half its time for thrashing and other purposes, say 15 per cent. on 115*l*. (half the price of the engine) will be 17*s*. 3*d*.; making together 2*l*. 2*s*. Mr. Pike considers from his present experience that 2*s*. per acre will pay for keeping the ropes in order, and purchasing new ones; so we must add 3*l*. per week for rope (when doing 30 acres in that time),—the total weekly expense thus amounting to 13*l*. 5*s*.; the wear and liabilities to damage costing considerably more than half as much as the working expenses. At 30 acres per week, the work will have cost altogether about 8*s*. 10*d*. per acre. The "crossing," at 50 acres a week, will have cost about 5*s*. 3*d*. per acre.

Now, whether or not a team of horses could pull the same implements at a lower outlay, it is quite clear that the steam-power cultivation is most profitable: and for these among other considerations. The work is far more valuable and efficient than horse-work could be, because of the rapid motion of the implement (which effects a better division of the soil, and shaking out and raising of weed to the surface), and the absence of an immense amount of trampling (which would again beat down much of the broken-up work). Work is enabled to be done in the dry baking autumn days, which, if horses were the sole power employed, would have to be left until winter and spring; consequently involving much more expense in tillage and cleaning than the steam-culture at the right time would have cost. For this reason, that is, for the sake of having the work done at a period when its effect is more beneficial than twice or thrice the amount of tillage performed in the long after-season of wetness and low temperature, farmers are willing to pay high prices for the work; so that (as I am informed) Mr. Pike broke up in autumn 25 acres of foul rough wheat-land, almost as tough as grass sods, for a neighbour,—for which he received the sum of 25*l*. Take the case of the 20 acres of wheat-stubble, steam-grubbed, crossed and cleaned in autumn, and

ridged-up for winter exposure, at a cost, from first to last, of some 20*s.* to 22*s.* per acre, and in a splendid condition for bringing a heavy crop of mangolds; yet had the only available motive-power been the largest force of horse-flesh that could be reasonably kept upon the farm, these 20 acres would have been unavoidably left to undergo a course of several winter and spring ploughings and scufflings, etc., at a cost of perhaps 3*l.* per acre, and then very likely not have been ready for bearing a root crop, and certainly in a much closer and sadder condition of texture than it is wrought into by the steam-cultivating and ample winter exposure.

Of Mr. Pike's 75 acres of fallow break, a portion has always been a dead summer fallow; the rest, tares, mangold, swedes, and common turnips: now, however, he will be able to have it all under crop. Instead of only 8 acres, he will have 16 acres of mangolds: there are 30 acres of vetches growing, after a portion of which, he will get a crop of rape, as the tare-stubble will be broken up in summer by the steam-engine. His present wheat crop, too, was got in vastly earlier than the farm ever knew before; all the seeding having been finished by the end of October. Mr. Pike formerly worked 15 horses every Michaelmas; this year he has "never had more than 11 collars on;" and the teams have rests as well, having had little to do since the middle of November, though previously they all used to be thoroughly worked down. The four horses disposed of have, in fact, gone a considerable way towards buying the cultivator-tackle; and as another item of gain, the labourers' wages have been considerably lightened during the winter, owing to the work having been so largely forwarded in autumn by the steam-machinery. I should state that Mr. Pike has the ropes originally supplied to him, but the amount of cultivating done has rendered them unequal to excessively hard operations, such as breaking up sun-baked lea-ground in summer, and hence he has been obliged to have a new set of steel ropes for such purposes, reserving the old ones for lighter operations.

On the same day that I went over Mr. Pike's farm I saw on Mr. Charles Howard's "Priory Farm," just out of Bedford, a piece of land laid up for fallow in the very best possible manner. The soil is a good loam, resting upon a yellow clay subsoil; the field had been a cleanish wheat-stubble, broken up 8 inches in depth by the steam grubbing-implement and afterwards crossed with a horse-cultivator. It was then thrown up into 27-inch ridges by means of a double mould-board or bouting plough, drawn by 2 horses, part of the piece being very deeply worked in this way by yoking 4 horses to the plough. Finally, Read's subsoiler was made to tear up the bottom of each open

drill; and, when the time comes for manuring, the farmyard muck will be spread along the rows, the ridges split with the double mouldboard plough, and the land will be ready for sowing with mangold or turnips. Of course, this trenching-up for winter is no new husbandry, but the steam-cultivator has put it in the farmer's power to treat all his fallows just as he does his kitchen-garden ground, only without the minute perfection of the spade or digging-fork.

In November, 1858, while inquiring into the merits of different systems of steam-tillage, I had an opportunity of witnessing some extensive operations of the Woolston apparatus in the hands of Mr. C. Randall, of Chadbury, near Evesham, Worcestershire. Evesham, in its beautiful vale watered by the Avon, is famed for its rich garden-soil,—a sand-loam, on which are grown acres of asparagus, onions, cabbages, cucumbers, green peas, and potatoes, with orchard-trees above them; yet so abrupt is the demarcation between the new red sandstone and lias formations, that Chadbury, three miles distant, is situated upon the strongest of heavy clay. Mr. Randall has farms on both descriptions of land, his occupation near Evesham consisting of good turnip-land loam and gravel, with patches of heavier soil intermixed. Without staying to detail the vast improvements by drainage, clay-burning, and high management; describing the mode of feeding half-bred sheep (crossed from the Shropshire) in yards bedded with a dry absorbent layer of red burnt clay; or referring, with the zeal of a sportsman, to the renowned breed of greyhounds; I proceed to a few particulars respecting the steam-culture.

Mr. Randall employs a Clayton and Shuttleworth's 8-horse engine, a windlass constructed by Messrs. Humphries of Pershore, a 3-tined Woolston grubber (with fish-tail shares of 9-inch width), manufactured by Messrs. Howard, and a pair of "twins," or heavy drag-harrows, suspended behind a beam mounted on wheels, so that the harrows can play up and down like the levers of a drill, this implement being adapted to the rope-traction by means of a light fore-carriage contrived by Mr. Randall himself. He proposes also to use a 5-tined grubber, so as to effect a larger breadth of work without leaving any portions unmoved.

On heavy clay, on very steep and lofty hill-sides, at Chadbury, where 4 horses can hardly plough at all going up and down, and must either take their plough up empty or work horizontally along the side, making bad work, the steam-cultivator answers to admiration; and in cleaning the foul land of his lately acquired occupation Mr. Randall has found its assistance invaluable: indeed, he was anxious to practise deep tillage, but dare not attempt it until

the surface had been cleared of its infesting root-weeds. Now, however, he has worked land with the steam implement first 6 inches deep, then a second time 8 inches, and over again, attaining a depth of 10 inches in all. He is much reducing the high-backed lands by scuffling across them, but prefers not to level them at a stroke because of sacrificing so much good soil that has been gradually accumulated on them. Some of the turnip-soil, broken up and then "twinned," I saw lying in a beautiful condition, apparently just as if forked by hand.

Other fields, also, I inspected, prepared for mangolds without ploughing, but all on the flat, instead of being ridged, as might be better, at any rate, on the heavier lands. Mr. Randall has prepared mangold land for wheat by two turns with the 3-tined grubber—the first time 6 inches deep, the next 2 inches deeper —and crossing with the twins. He has broken up ground directly after an early harvest, sown white mustard, had sheep feeding it off in about six weeks' time, and could have grown vetches after that; and he has also broken up clover-lea for wheat—that is, rather a dead lea, the live rubbish dying when exposed on the surface, and the couch and docks being picked off, and the wheat put in without any necessity for ploughing. I will here insert his own written testimony of a year ago.

January 30, 1858.

Dear Sir,—I am happy to add my testimony to the value of your steam-cultivator, which I procured from Messrs. Humphries in July last. I have worked it upon a variety of soils, and in all cases most satisfactorily. Having recently added to my previous occupation about 200 acres of good light land, very full of couch-grass, I have found the cultivator most valuable since harvest in preparing the stubble for this year's root crops. The first operation was to lift this couch to the surface by passing the cultivator under it at a depth of about six inches. This left it in a better state to eradicate than two ordinary ploughings would have done: for be it remembered that the custom has been, when commencing the cleaning of a foul piece of land, to turn the couch into the bottom of the furrow; the next, to plough it back again, or so much of it as during this second ploughing did not fall back into the furrow, to be firmly planted there by the horses' feet. Your implement keeps it in sight—all is on the surface, and by harrowing, rolling, raking, and picking, may be cleared away. This done, a second stirring with the cultivator, ten to twelve inches deep, leaves the land in the best possible state to benefit by the frost, and will need no other ploughing except to cover the manure.

Valuable, however, as I find the cultivator for the above purposes, it is still more so upon my clay land, of which my farm here (about 500 acres) chiefly consists. . . . . . The difficulties attending the cultivation of clay land, even upon steep hill sides, as is the case with some of mine—thanks to you—are now at an end.

Believe me, dear Sir, faithfully yours,

C. Randall.

Mr. W. Smith, Woolston.

During the year after this letter was written Mr. Randall has steam cultivated, I think, about 300 acres. The condition of the ropes is this: the original ropes had been turned end for end upon their respective drums, but, owing mainly to the small diameter and defective form of the snatchblocks, kept breaking so continually when used for great areas of ground that new lengths were obliged to be added in order to be able to work 20 acres without removing the windlass and turning the engine round. There may be now some 400 to 500 yards of new rope, and perhaps 250 yards of old rope, upon each barrel, so that the old portion is in use only for very long lengths of field. Since the addition of new rope, about 120 acres had been done when I saw the tackle; the iron-wire rope, very well coiled, was perceptibly worn and polished by the friction, though the strands were not flattened, crushed, or opened. Mr. Randall considers that the cost incurred by the rope alone will be 1*s.* per acre, which, however, I think will prove to be too low an estimate. Reckoning the working expenses, and allowing 15 per cent. for wear and tear of the tackle and the engine (which is a good allowance, seeing that the engine is used for other purposes, and will last a very long time), the total cost may be set at about 12*s.* an acre for the 4 acres a day done on the strong land, and say 8*s.* or less per acre for the more expeditious light-soil operations. The apparatus, having been purchased in July, 1857, has worked for two summer and autumnal tillage seasons, besides some early winter and spring operations; and Mr. Randall is quite satisfied as to its great value and profitableness, but now feels the want of a 2 or 3-furrow turnover-plough for burying manure and for various other processes which the simple scuffling cannot so well accomplish.

Though I have given the results of steam cultivation on some very extensive farms, as practical illustrations of the working of the Woolston method, yet, without referring to Woolston itself, my essay would be too much like the play with "the part of Hamlet omitted." Therefore, a few statements are required respecting the management in this first instance of a whole farm tilled by a steam-engine. Mr. Smith farms at Little Woolston, near Bletchley, Bucks, about 200 acres; 110 of which are arable, partly a hilly cold clay, and the remainder a mixed gravelly clay. The ruinous dead fallow is abolished, yet the farm is a pattern of cleanly culture; and without purchasing artificial manures, very heavy yields both of wheat, barley, pulse-crops, and roots, are grown with a regularity and certainty previously unknown. This strong soil is chemically rich in the mineral nutriment required by vegetation, but naturally in a defective mechanical condition, needing only to be kept open and porous, and per-

meated by atmospheric agencies, to yield up its native and continually absorbed stores of fertility in prolific abundance to the roots of acquisitive plants. And by deep pulverizing and weed-eradicating steam tillage, without expensive digging or horse trench-ploughing, the land has now become deep, rich, and friable as a garden, of which the noble specimens of mangold exhibited at the last Baker-street Show, are pretty good evidence.

I have not seen Mr. Smith's farming since July, 1857, when I made one of a large concourse of visitors assembled for a "field-day." At that time, a 3-tined grubber, worked by a 7-horse threshing-engine, was tearing up a stiff-clay clover-lea to a depth of 7 or 8 inches. This field had been under oats before the clover, beans the year before, and wheat before that, soon after a fallow, and had borne all these crops without once being turned over with the plough, yet the land was clean as a garden. In other fields I saw growing magnificent crops of peas and oats also upon steam-tilled land. This wheat had been put in without ploughing, the ground was prepared by once breaking-up (5 acres a day including "shifts") with the steam-grubber at 5*s.* 2*d.* per acre, and once crossing with a horse cultivator at 2*s.* per acre, or 7*s.* 2*d.* altogether, to which add 1*s.* 6*d.* per acre for wear and tear, making a total cost of 8*s.* 8*d.* an acre. Contrast this with the old method in which one ploughing with horses would alone cost 14*s.* For his mangold crop he had simply carted 12 loads of farmyard manure on to a clean wheat-stubble (for his system of never burying the "filth" kept the land free from couch), worked his double-mouldboard plough with subsoil tines following, so as to trench 10 inches deep, throwing the land into drills or ridges, and covering up the manure within them; this cost 8*s.* 8*d.* an acre. He then bottomed the open spaces with his single-tine subsoil plough, drawn by horses, at 3*s.* per acre, making 11*s.* 8*d.*, to which add 1*s.* 6*d.* for wear and tear, bringing the total cost up to 13*s.* 2*d.* per acre. How many farmers have prepared their land for drilling or dibbling mangold at anything like so small a cost? Beans I found a magnificent crop, and the wheat very heavy, promising 6 quarters per acre, and in beautifully clean condition.

Mr. Smith stated, that while he had always worked five or six horses and a strong pony under the old order of things, he last year sold off three horses; since then the two horses and the pony supplementing the work of the 7-horse power steam-engine (which was cultivating only 20 days in a year), had performed all the tillage and draft-labour of the farm, excepting, indeed, that horses had been borrowed from his Bedfordshire occupation to assist in harvesting, in subsoil-ploughing, and a

little manure-carting; but his home-farm horses had had long furloughs, and he had paid back far more motive-power than he borrowed, by working on the other farm with the steam-cultivator. In future, he proposed to keep breeding mares, and have altogether three and the pony, so as to manage without borrowing any horseflesh. He showed that day, beans, mangolds, turnips, clover, barley, and wheat, growing upon steam-tilled land. As he had sold his three horses at 30*l.* a piece, and saved their keep and depreciation, &c., valued (on a clay farm) at 90*l.* more, he had thus gained 180*l.* in one year; which was just about the prime cost of his steam-tackle, exclusive of the engine that did his threshing, grinding, cutting, &c., and also work for other people. In manual labour he looked for no saving; the labourer should have better wages now that he became an engineer or machine-man: and as the couch was killed, and annuals had little chance of growing, his *quondam* horse-keepers, armed with sharp hoes, kept his green crops clear of weeds. Mr. Smith still continues his management with extraordinary success, requiring the turnover-plough only for burying the live vegetation of a clover lea.

List of Persons using Smith's Steam Cultivating Apparatus in the United Kingdom, no Foreign ones included.

Bedfordshire	Mr. W. Pike, Stevington.
,, ...	Mr. J. Topham, Eaton Socon.
Berkshire	Mr. Pullen, Sutton Courtney.
,, ...	Mr. R. Benyon, Upton.
Buckinghamshire ..	Mr. Thomas Revis, Olney.
,, ..	William Smith, Little Woolston.
,, ..	Baron Rothschild, Mentmore.
,, ..	Mr. Whiting, Stoke Goldington.
,, ..	Mr. W. Nichols, Moulsoe.
,, ..	Mr. Baker, Loughton.
,, ..	Mr. Nickson, Loughton.
,, ..	Mr. Bignell, Loughton.
,, ..	Mr. W. Hensman, Linslade.
,, ..	Mr. Riley, Chicheley.
Cambridgeshire ..	Mr. Edward Eye, Cambridge.
Gloucestershire ..	Mr. Henry Butt, Kemerton.
Herts	Mr. R. Nicholson, Much Hudam, Ware.
Huntingdonshire ..	Mr. W. Cranfield, Buckden, St. Neots.
,, ..	Colonel Linton, Buckden, St. Neots.
Lincolnshire	Mr. T. B. Dring, Claxby, Spilsby.
,, ...	Mr. Wass, Asgodby.
Northamptonshire ..	Mr. Montgomery, Heathencote, Towcester.
,, ..	Mr. Faux, Yaxley, near Peterborough.
,, ..	Mr. W. Stanley, Peterborough.
,, ..	Mr. Bartlett, Witfield.
Norfolk	Mr. R. Coe, Tilney, Lynn.
Oxon	Mr. Griffin, Fowersey.
Staffordshire	Mr. H. Stanley, Yeald Hall, near Walsall.

Staffordshire ..	.. Lord Hatherton, Teddesley.
Warwick ..	.. Mr. J. Broadhead, Twycross.
Wiltshire ..	.. Mr. J. B. Starkey, Spye Park, Chippenham.
Worcestershire	.. Mr. J. Smith, Dumbleton.
" ..	.. Mr. Randall, Chadbury.
" .	.. Mr. G. Humphries, Pershore.
Yorkshire ..	.. Mr. Coulson, Drax Hall, Selby.
" ..	.. Mr. P. Stevenson, Rainton, Thirsk.
Ireland	.. Mr. R. Nasen Gaggin, Bally Richard, Middleton, County Cork.
Scotland	.. Marquis of Stafford for his Scotch Estate.

Favourable as have been the results detailed, and equally satisfactory as may have been the experience of others among this list of agriculturists, yet the evidence in some cases would tell against the mechanical arrangements, as involving too much labour, great loss of power, and excessive wear and tear. And some farmers, again, while failing to meet with the facilities they had anticipated from other examples, are persevering, in spite of frequent and delaying breakages (which, indeed, teach their men handiness in "splicing"), and striving to work turn-over ploughs (still found indispensable on a majority of soils), with an apparatus not qualified to do so economically. There is no doubt that the difference between careful and reckless management, as well as the varying merit of the mechanical details, and of the quality of the rope supplied, have tended to make steam-cultivation either profitable or too costly.

I have visited the farm of Mr. Bird, of Littywood, near Penkridge, between Wolverhampton and Stafford, where one of Mr. Fowler's steam-ploughs has been adopted. The soil varies from a hard red-brown conglomerate of clay and pebbles, stiffened in the ancient days by enormous applications of "kag marl" from the great pits which still gape in every field with openings more than 20 feet deep, to lighter land where the gravel predominates. Bare fallows were customary, but are giving way to a more profitable growth of mangold, turnips, &c., partially eaten off by sheep. The fashion was to plough in "five-bolt butts," that is, small lands or stetches of ten furrows each; and the work being thus all "cops" and "reanes," not only was there a waste of ground from such a redundance of water-furrows, but there was a great loss of time in ploughing, by having to gather up the land.

By means of good pipe-drainage, 3 or 4 feet deep, Mr. Bird, who farms 600 acres, only a small proportion of which is pasture, has been able to practise ploughing on the flat, with the result of a considerable increase of yield in his crops, in spite of the taunts and forebodings of neighbouring

managers, who prophesied a beautiful *irrigation* of his wheat after a smart rain-fall. Horse-ploughing 6 inches deep is done with four horses; and the "custom of the country" allows the outgoing tenant only 10*s.* for the operation, whereas the four horses at, say, 2*s.* 6*d.* each, man 2*s.* 6*d.*, and boy 8*d.* per day, make an expense of 13*s.* to 15*s.* an acre. When the work is heavy, or at a depth of 7 or 8 inches, and only 3 roods a day can be done, the cost amounts to 17*s.* or 20*s.* per acre; and deep ploughing is specially demanded on this over-marled land, in order to bring up the somewhat lighter stratum lying beneath.

Mr. Bird has turned over a considerable extent of land with the steam-plough, some as much as 8 inches in depth; the principal part of the work averaging 6 to 7 inches. In 15 days about 70 acres were ploughed, and six removals made, averaging about half a day each, as some of the fields were a long way distant from each other. This is equivalent to about 6 acres for a full day's work, that is from 7 to 5 o'clock, with half an hour's stoppage for breakfast and an hour for dinner. In a 10-hours' day of course a larger amount of work would be accomplished. To have accomplished the 70 acres in 15 days would have required 20 to 24 horses, working 5 or 6 ploughs. But the force of teams kept upon the farm would have been perhaps 10 days longer in doing the same extent of work, and the wheat seeding has not only been forwarded thus much, but has been still further accelerated by the horses getting on with harrowing and drilling while the steam-plough is at work simultaneously, instead of having to wait for their own slow ploughing. And the setting-in of a week's frost has still more strongly enforced the advantage of this expedition. The steam-ploughing has been well done; the slices are well turned, and so shaken by the rapid motion of the implement, and loose from the absence of trampling, that less reduction of the surface by harrows is found necessary, and the ground is in a better condition for the seed to strike in. The fields are hilly and by no means rectangular, yet the engine on one headland and anchorage on the other travel without obstacle or difficulty, the rope being led out or taken up to suit the fluctuating length of the furrow, which varies from 400 to 200 yards and less. In one field the plough, turning three heavy furrows (though four furrows at a time on all but the strongest land), descended into and mounted out of a partially-filled marl-pit 20 feet deep, the sides sloping with a "batter" of 1 in 2, and in some places an angle of 45°.

What have been the items of expense for these 15 days' work?

	£.	s.	d.
Labour—3 men and 2 boys, coal, oil, and water-carting, about	22	10	0
Extra for removals (only 2 horses being required, owing to the engine being locomotive)	0	18	0
Wear and tear, and interest, say 20 per cent.— On engine .. .. £420; On apparatus .. 420; 840 — charged on 200 days in the year	12	11	3
	£35	19	3

The working expenses on the 70 acres are thus ..	6*s.* 8*d.*	per acre
The wear and tear, interest, &c.	3 7	,,
Total, about	10*s.* 3*d.*	per acre.

The cost by horse-labour would have been one-third to one-half more, besides the work, in that case, being so far behind-hand, and so much less efficiently performed. I should add here, that several days' delay occurred at first, by the fracture of one of the spur-wheels on the windlass, the engine (of 12-horse power, but working up to 25 or 30) being too powerful for the machinery; and also with a stoppage arising from a new and untried attachment of the hooks to the ends of the ropes. Mr. Bird's steam-ploughing apparatus is almost independent of horses for shifting from field to field, the engine being one of Mr. Smith's (of Coven) locomotives. This travels from field to field, or from one farm to another, with only a single horse to steer the engine; even this, however, is unnecessary, as the engine may be steered by hand, but a horse being required to lead out the rope, &c., in the field, he is put into a pair of shafts on his way there. One horse is also employed to take the balance plough, while the windlass and the anchorage are both yoked behind the engine. To shift a portable engine with the whole machinery would require ten horses if going a considerable distance; four horses, if merely from one field to an adjacent one, in which case the team can make several journeys in a half-day. If we take five horses as the average number required, the cost of the six removals would have been, say, 43*s.* instead of 18*s.*, that is, the expenses of ploughing would have been more by 4*d.* per acre, and in the case of travelling a few miles the cost would be 8*d.* or 1*s.* an acre more with a common portable than with a locomotive engine. Of course we must deduct something for the cheaper prime cost of the simple portable, but the saving of a small price per acre is of less importance than the advantage of being able to take the apparatus to its work without hindering the team from the sowing or other urgent operations they may be engaged about.

As the season was far advanced when the above facts were ascertained, Mr. Bird has ploughed only about 20 acres more, or 90 altogether; and he is having cultivator-tines attached to the ploughing-frame, ready for working up fallows this spring.

The next illustration of the worth of the steam-plough embraces results on a still larger scale.

Mr. Thomas H. Redman, of Overtown, near Swindon, farms on the hills in the vicinity of the chalk downs, but though you see fine turnips and Swedes growing, and the spade finds chalk rubble and pebbles at 5 to 15 inches below the surface, there are plenty of indications savouring strongly of a heavy soil; a considerable breadth of bare fallows; the ground light-coloured, but hard and brittle in dry weather or stony like concrete; and, when wetted by a shower, greasy, slippery, or sticky, like birdlime, making heavy work alike for the antique wooden plough of the neighbourhood or the steel mould-board of Howard's modern one. Naturally drained by the soft rock beneath, this forms a rich, unctuous soil, tiresome in wet weather, and "mauly" enough under the feet of the ploughman, but requiring only a greater depth and perfection of tillage, and freedom from the kneading tread of the team, (solidifying a mass already too consolidated,) to produce far greater yields than are at present raised, and become no longer a costly, but a grateful calcareous clay. On 430 acres arable, 7 ploughs are requisite, and the team kept to work them consists of 13 horses and 13 oxen; 3 horses or 4 oxen ploughing a furrow 4½ or 5 inches deep.

It is quite possible that the powerful high-priced horses used by Mr. Redman might be exchanged, with mechanical advantage, for more active and naturally quick-stepping horses; but still it will remain true that excessively heavy work has to be done, for I myself tested the draught of a Howard's iron plough with steel mould-board, finding it to be in two fields 6 cwt. for a furrow 10 inches wide and 6 inches deep, and in two other fields no less than 10 cwt. for a furrow 10 inches wide and 7 deep. The frost was out of the ground when these trials were made, but the labourers declared that the work went far easier than is frequently the case.

The customary allowance to a tenant for one ploughing is 8*s*., 10*s*., or 12*s*. an acre; but it evidently costs much more, and, after all, the work is most imperfectly and miserably done. The winter ploughing Mr. Redman estimates at 16*s*. per acre, reckoning horse-keep at 2*s*. a head per day. However, as each horse has 1½ bushels of oats per week, with wheat-chaff, and 1½ cwt. of hay, I should take the daily cost of a horse at 2*s*. 6*d*., making the work considerably dearer. Ploughing by oxen, at the rate of 4 acres a week for each team of four, he has carefully

estimated as costing 5*s.* 6*d.* in summer and 8*s.* 6*d.* in the time of winter keeping; but the work is shallow, the injury by trampling and poaching very great, and woefully inferior to that required by this land, but which teams are utterly unable to perform at all. Three horses, costing 15*s.* each per week, and a man and a boy 10*s.* (in this county of low wages), amount to a sum of 55*s.*; and the 4 acres ploughed in this time cost therefore nearly 14*s.* per acre. Consider, moreover, that the depreciation in value of the horses on such land as this is a heavy matter, besides the interest of first cost, and the expense of harness, implements, &c., to be added. Some of the work done by the steam-plough was 7 inches deep, bringing up 2 inches of the hard subsoil, and the draught of a furrow being 10 cwt. showed that six horses would be required in order to achieve such an operation.

Yes, light land-managers! a horse cannot drag 2 cwt. all day here as he could with you, because of the labour involved in the bad walking—an element that ought never to be lost sight of in calculating horse-power. Six horses would do little more than half an acre a day, say 4 acres per week; and the cost then amounts to upwards of 25*s.* per acre, or considerably more, including depreciation, interest, and contingencies.

No wonder then that Mr. Redman should make up his mind (as great numbers of farmers similarly placed will be found to do) to try steam-ploughing. Having purchased one of Mr. Fowler's sets of tackle, with a 10-horse power double cylinder engine, he has turned over 150 acres in about thirty-five days of actual work, or an average of nearly 4½ acres per day: 11 acres of the heaviest work of all were completed in four days. The estimated expense, reckoning wear and tear, and interest at 20 per cent., and two hundred days' work in the year, at 5 acres a day, and say one removal in a week—the fields being large—comes to about 9*s.* per acre average; the heaviest work to about 15*s.* per acre: from which it appears that the steam-plough has worked at about one-third to two-fifths less expense than the animal power. This cheapness of tillage, however, is a small consideration compared with the saving of time, the depth and excellence of the work, the keeping of fewer horses, &c.

In thirty-five days of working, including seven removals, 150 acres have been steam-ploughed, averaging nearly 4½ acres a day. This may appear a smaller extent of work than might be expected, but then a large proportion of the ploughing was extremely heavy and laborious, and in one field 11 acres were turned over in four days, though the draught of a single furrow there (with a horse plough) is not less than half a ton. The expense of this tremendous work I have computed to be fully 25*s.* per acre by

horses, and only 15*s.* by steam. The general average cost of the steam-ploughing has been a little over 8*s.* an acre, yet it is 2 inches deeper than the farm-teams have hitherto done it. Mr. Redman has kept accurate memoranda of all the expenses, &c.; and from these items I have been enabled to form the following estimate of the expenses for one week:—

	£	s.	d.
Labour—2 men at 20*s.*	2	0	0
,, 1 man at 12*s.*	0	12	0
,, 2 lads at 6*s.*	0	12	0
Water	1	1	0
Coals, 3 tons at 20*s.*, oil, &c.	3	3	0
Removals twice a week, each requiring four horses, &c., for a quarter of a day	0	7	0
	7	15	0
Wear and tear and interest, say 20 per cent. on the first cost of engine, and all the machinery (equal to 750*l.*) charged on 200 days in the year	4	10	0
	12	5	0

	per acre.		
	£	s.	d.
The working expenses on 30 acres per week are thus	0	5	2
Wear and tear, and interest	0	3	0
	0	8	2

Mr. Fowler's own estimate of the annual cost of keeping the apparatus, &c., in complete repair, replacing the wire-rope as it wears, &c., is not far different from the above 20 per cent.; and it is based upon very extended experience of such wire-rope and machinery:—

	per annum.		
	£	s.	d.
Renewal of the steel rope per year	35	0	0
Maintaining the windlass and tackle in order ..	25	0	0
Ditto boiler and engine	15	0	0
	75	0	0
Contingencies	25	0	0
Expense of preserving the efficiency of the whole machine	100	0	0
Interest of outlay 5 per cent. on 750*l.*	37	10	0
	137	10	0*

* The items of interest, and wear and tear, have been considerably lowered since the above figures were calculated, owing to the simpler and cheaper construction of the apparatus.

Let us now inquire how far the purchase of the steam-plough promises to be a good speculation. Mr. Redman is selling off 3 horses and 13 oxen, leaving only 10 horses to perform the light tillage, carting, &c.:—

	£	s.	d.
The 3 horses, remarkably powerful and good animals, at 40*l*.	120	0	0
The 13 oxen, worth 17*l*. 10*s*. each at present prices	227	10	0
Proceeds of the sale	£347	10	0

So that the exchange of the draught animals for the steam-plough leaves little more than half the prime cost of the machine to be earned by its working. How long, therefore, will the machine be in clearing itself? Well; in seven weeks of work, delays, and "first start" mishaps, the actual saving in the cost of ploughing amounted to at least 10*s*. per acre on 150 acres, that is, 75*l*. altogether. Of course the comparison is made with the expense of horse-labour ploughing to the same depth, and not with the shallow work, which has been hitherto effected. In ploughing for fallows, in spring tillage, in preparing for the root crop, in summer working the bare fallow, in breaking up the autumn stubbles, will there not be a greater acreage worked than has been done merely in this "wheat-seeding?" and, at the same proportionate economy of operation, will not the farmer be yet more in pocket during the remainder of the year than has accrued during the aforesaid seven weeks? It appears to me that, simply in the cheapness of working, the whole machinery will pay for itself in about a couple of years, and this result is certainly a startling one.

Whether the 7-inch ploughing will pay for doing, instead of the 4½ or 5-inch, is scarcely open to question, there being such an amount of evidence in support of the practice; and this is just a soil needing deep tillage, and quite solid enough to allay any apprehension as to the success of the wheat sown after such ploughing. What precise money value may be assigned to the additional benefit of having all the wheat sown, as it now is, a fortnight or three weeks earlier than it could have been without the steam-plough; what may be the value of an advanced state of preparation for spring cropping and roots; the gain by additional working of fallows (in a district where each summer stirring is considered equivalent to 4 bushels increase in the yield of corn). What, again, the saving in cleaning by autumnal culture (for which purpose more especially the Woolston cultivator is so highly regarded) I cannot undertake to put in figures. But whether these advantageous points be taken singly or together, no doubt remains as to the amazingly beneficial results derived

from steam-ploughing. At any rate, what with economical performance, improved work from the absence of trampling, and the three-and-a-half-mile per hour speed of the implement, the expedition and other advantages I have alluded to, it is clear that Mr. Redman has made a move in a safe direction; and time alone can show what the effect will be in empowering him to adopt a higher order of culture and a reformed system of cropping.*

The present Essay can be regarded only as a summary of progress up to the date subjoined; and this must be its apology for not describing still later improvements; nearly every week producing some novelty in steam-tilling machinery, or furnishing yet stronger evidence of its value to the farmer.

Long Sutton, Lincolnshire, February, 1859.

XIV.—*Report of Experiments with different Manures on Permanent Meadow Land.* By J. B. Lawes, F.R.S., F.C.S., and Dr. J. H. Gilbert, F.C.S.

Parts II. and III.

(Continued from Vol. xix., p. 573.)

Part II.—Produce of Constituents per Acre.

In order that the more directly practical conclusions to be drawn from the experiments might be brought out more prominently,

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* In the following letter to Mr. Fowler, Mr. Redman states the total number of acres steam-ploughed by him in the autumn, and again during last spring:—

Overtown, near Swindon, 17th May, 1859.

My dear Sir,—The set of Steam Plough Tackle you sent me, at the end of September last, has done good service: the more I use it the better am I satisfied with steam cultivation. Under no use of animal strength could the land be left in the mild and healthy state it at present presents. I have 60 acres under preparation for roots, which is in a very different condition from what it would have been had it been ploughed by cattle, and altogether different to what my land for roots has been at this time in former years. The quantity of land ploughed by me with steam last autumn was 210 acres—at a cost of 112*l.* 10*s.* 6*d.*, including incidental expenses, and a first start (this was accomplished by the 4th January)—in 50 working days, being $4\frac{1}{4}$ acres per day, which completed our winter work. In future I hope to finish all autumn cultivation by the end of November. I again brought out the tackle in March, and ploughed above 40 acres for a neighbour; since which I have ploughed 95 acres, and scarified 14 in 21 days, or about $5\frac{1}{4}$ acres per day. The cost of this I am not able to state accurately, as there are some bills not yet paid, but think I am safe in saying that it will not exceed 7*s.* per acre. The acreage cost I have no doubt will be much reduced when you send me a new set of your standard apparatus (as there will be less liability to casualties); this I shall be glad to have as soon as convenient. . . . . .

I am, &c.,

T. H. Redman.

attention was confined in the former section of our Report almost exclusively to the nature of the manures employed, and to the amounts of the gross produce or increase of hay obtained by their use. A few passing remarks only were made upon the variable character of the herbage, according to the description of manure employed. But there are other aspects of the subject than those hitherto considered, which are well worthy the attention of the intelligent farmer.

The permanent meadow land of a farm stands in a somewhat isolated position in regard to the crops under tillage. In the case of the *rotation* crops, the straw of the corn ones, the larger portion of the most important manurial constituents of the green crops, frequently the manure from the consumption of the hay of the meadow land itself, and perhaps that from imported cattle-food also, will, at least once in the course, find their way to the arable land. But the meadow land does not generally come in for a due share of restoration of constituents by the home manures. Hence it happens, that the amount of constituents actually carried from the land, year by year, in the hay crop, has generally a more direct influence on exhaustion, than that harvested in the rotation produce.

It is important to consider then—what amounts of the several constituents are taken from an acre of land in an ordinary crop of hay?—what is the drain of them, which the stores of the soil, or the supplies of other manures, are called upon to meet, when the produce is increased by means of active portable manures?—and further, what is the proportion of the active manurial constituent *nitrogen* supplied in such manures, that is recovered in the increase of crop obtained by its use?

It is also essential to a right appreciation of the action of different manures upon the grass-crop, carefully to ascertain their influence upon the development of the different plants of which the mixed herbage is made up, and at the same time to take into consideration the recognised comparative qualities of the different plants so developed.

Lastly, with a great variation in the proportion of the different plants developed, and in the degree of their maturity at any given time, according to season and the manure employed, it is obvious, that there must be corresponding variation in the per-centage composition of the complex produce—*hay*. The influence of the different manures upon the *chemical composition of the hay* constitutes, therefore, another important point of inquiry.

It would perhaps, in some points of view, be more in order to give the results of the analyses, and with them to consider the *per-centage* composition of the hay, before treating of the *acreage* yield of the several constituents, calculated by means of those

results; but it will, upon the whole, be more convenient to complete the subject of the *quantity* of produce before commencing upon that of *quality*.

Having, therefore, in Part I., considered the acreage amounts of the *gross produce*, or *hay*, attention will be directed in the present section (Part II.) to the acreage quantities of certain *constituents*, or *classes of constituents*, obtained by the different manures.

Part III. will be devoted to the discussion of one element of quality, namely, that of the description and proportion of the different plants developed.

Lastly, in Part IV., the *per-centage composition* of the complex produce—*hay*, will be considered.

The particulars relating to the amount of the several constituents, per acre, contained in the produce by the different manures, are given in a series of Tables, as follow:—

In Table III.—The produce of hay, per acre, calculated in lbs., as the basis of the succeeding Tables.

In Table IV.—The produce of total *dry substance*, per acre, in lbs.

In Table V.—The *mineral matter* (ash), per acre, in lbs.

In Table VI.—The *nitrogen* in the *total produce*, per acre, in lbs.

In Table VII.—The *nitrogen* in the *increase by manure*, per acre, in lbs.

In Table VIII.—The *proportion* of the *nitrogen recovered in increase, for* 100 *parts supplied in manure*.

1. *The Dry Matter per Acre.*

On the amounts of *dry matter*, per acre (Table IV.), a very few observations will suffice. Taking the average of the three years over which the experiments extended, the annual yield of dry matter was, *without manure*, almost exactly a ton per acre. This is slightly under the amount obtained, without manure, in *wheat* (corn and straw together), taking the average of fourteen years of the consecutive growth on the same land; and it is several hundredweights below that obtained in *barley*, without manure, taking the average of six years' consecutive growth on the same land.

By means of *manures*, the yield of dry matter, per acre, in the hay crop, was in several of the experiments considerably more than doubled. The increased produce of dry matter was thus great—indeed the greatest—where no carbonaceous manure whatever was employed. It may be reckoned that the dry substance of the hay would contain about 40 per cent. of carbon. Adopting this estimate, there would be about 900 lbs. of carbon assimilated per acre,

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE III.—PRODUCE of HAY per Acre: lbs.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	ANNUAL PRODUCE. 1856.	1857.	1858.	Average of 3 Years.	Average Annual Increase by Manure.
	SERIES 1.—Without Direct Mineral Manure.					
1	Unmanured	2515	2856	2472	2614	..
2	Unmanured (duplicate plot)	2351	2592	3360	2768	..
	Mean, or Standard Unmanured	2433	2724	2916	2691	..
3	2000 lbs. Sawdust	2312	2340	2244	2299	−392
4	200 lbs. each, Sulphate and Muriate Ammonia	4028	3774	3982	3928	1237
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	3953	3710	4166	3943	1252
6	275 lbs. Nitrate of Soda	..	..	2952	..	261
7	550 lbs. Nitrate of Soda	..	..	3564	..	873
	SERIES 2.—With Direct Mineral Manure.					
8	*"Mixed Mineral Manure"	3429	3666	4082	3726	1035
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	3711	3994	4376	4027	1336
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	6363	6422	7172	6652	3961
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	6369	6428	6892	6563	3872
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	5412	6050	6752	6071	3380
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	6970	6940	7508	7139	4448
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	4236	..	1545
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	5646	..	2955
	SERIES 3.—With Farmyard Manure.					
16	14 Tons Farmyard Manure	4030	5328	4164	4507	1816
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	5009	6008	5320	5446	2755

* For full description of the "*Mixed Mineral Manure*," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE IV.—PRODUCE of TOTAL DRY SUBSTANCE per Acre: lbs.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	ANNUAL PRODUCE. 1856.	1857.	1858.	Average of 3 Years.	Average Annual Increase by Manure.
	SERIES 1.—Without Direct Mineral Manure.					
1	Unmanured	2061¼	2431¾	2124½	2205½	..
2	Unmanured (duplicate plot)	1885¾	2262¾	2872	2340	..
	Mean, or Standard Unmanured	1973½	2347¼	2498¼	2273	..
3	2000 lbs. Sawdust	1866¼	2052¼	1893½	1937¼	−335¾
4	200 lbs. each, Sulphate and Muriate Ammonia	3222½	3272	3348	3280¾	1007¾
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	3148¼	3251½	3496	3298½	1025½
6	275 lbs. Nitrate of Soda	..	..	2503¼	..	230¼
7	550 lbs. Nitrate of Soda	..	..	3059¼	..	786¼
	SERIES 2.—With Direct Mineral Manure.					
8	"Mixed Mineral Manure"	2751½	3179¾	3493½	3141½	868½
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	2987½	3466¾	3679¼	3377½	1104½
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	5024¼	5591½	5889½	5501¾	3228¾
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	4924½	5606½	5778¼	5436½	3163½
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat Straw	4286¾	5249½	5562¾	5033	2760
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	5445	5967	6057½	5823	3550
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	3660¾	..	1387¾
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	4811½	..	2538½
	SERIES 3.—With Farmyard Manure.					
16	14 Tons Farmyard Manure	3068½	4652½	3521	3747¼	1474¼
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	3985¼	5181¼	4400¾	4522½	2249½

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE V.—PRODUCE of TOTAL MINERAL MATTER (Ash), per Acre : lbs.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	ANNUAL PRODUCE. 1856.	1857.	1858.	Average of 3 Years.	Average Annual Increase by Manure.
	SERIES 1.—Without Direct Mineral Manure.					
1	Unmanured	157·4	160·7	141·0	153·1	..
2	Unmanured (duplicate plot)	156·1	148·0	186·8	163·7	..
	Mean, or Standard Unmanured	156·8	154·4	163·9	158·4	..
3	2000 lbs. Sawdust	153·0	132·0	113·8	132·9	−25·4
4	200 lbs. each, Sulphate and Muriate Ammonia	259·4	206·8	204·5	223·6	65·2
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	237·5	206·5	222·1	222·0	63·6
6	275 lbs. Nitrate of Soda	..	..	169·1	..	10·7
7	550 lbs. Nitrate of Soda	..	..	191·7	..	33·3
	SERIES 2.—With Direct Mineral Manure.					
8	"Mixed Mineral Manure"	237·4	225·8	264·5	242·6	84·2
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	271·3	263·4	283·2	272·6	114·2
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	431·2	403·3	468·5	434·3	275·9
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	447·9	412·4	468·7	443·0	284·6
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat Straw	364·1	394·9	451·2	403·4	245·0
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	457·9	445·5	476·6	460·0	301·6
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	271·1	..	112·7
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	368·1	..	209·7
	SERIES 3.—With Farmyard Manure.					
16	14 Tons Farmyard Manure	293·9	346·7	279·8	306·8	148·4
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	376·5	387·6	358·4	374·2	215 8

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE VI.—PRODUCE of NITROGEN per Acre: lbs.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	ANNUAL PRODUCE. 1856.	1857.	1858.	Average of 3 Years.	Average Annual Increase by Manure.
	SERIES 1.—Without Direct Mineral Manure.					
1	Unmanured	42·2	36·8	34·6	37·9	..
2	Unmanured (duplicate plot)	42·1	38·1	45·0	41·7	..
	Mean, or Standard Unmanured	42·2	37·4	39·8	39·8	..
3	2000 lbs. Sawdust	38·6	32·3	31·6	34·2	−5·6
4	200 lbs. each, Sulphate and Muriate Ammonia	63·2	58·5	65·7	62·5	22·7
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	62·8	55·3	65·0	61·0	21·2
6	275 lbs. Nitrate of Soda	..	..	49·6	..	9·8
7	550 lbs. Nitrate of Soda	..	..	60·9	..	21·1
	SERIES 2.—With Direct Mineral Manure.					
8	"Mixed Mineral Manure"	57·3	55·4	57·1	56·6	16·8
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	65·7	59·1	60·8	61·9	22·1
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	78·3	75·8	89·6	81·2	41·2
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	80·2	71·3	80·6	77·4	37·6
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat Straw	79·5	80·8	91·1	83·8	44·0
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	103·8	112·4	128·4	114·9	75·1
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	64·4	..	24·6
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	74·5	..	34·7
	SERIES 3.—With Farmyard Manure.					
16	14 Tons Farmyard Manure	54·4	69·8	49·1	57·8	18·0
17	**14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia**	81·1	64·9	67·6	71·2	31·4

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE VII.—NITROGEN per Acre in INCREASE where a Known Quantity was supplied in MANURE: lbs.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Increase over the Produce without Manure.				Increase over the Produce by the "Mixed Mineral Manure."			
		1856.	1857.	1858.	Average of 3 Years.	1856.	1857.	1858.	Average of 3 Years.
	SERIES 1.—Without Direct Mineral Manure.								
4	200 lbs. each, Sulphate and Muriate Ammonia	21·1	21·0	25·9	22·7	..	..	..	..
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	20·7	17·8	25·2	21·2	..	..	..	..
6	275 lbs. Nitrate of Soda	..	..	9·8	..	..	..	..	..
7	550 lbs. Nitrate of Soda	..	..	21·1	..	..	..	..	..
	SERIES 2.—With Direct Mineral Manure.								
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	36·1	38·3	49·8	41·4	21·0	20·4	32·5	24·6
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	38·1	33·9	40·8	37·6	23·0	16·0	23·5	20·8
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat Straw ..	37·4	43·4	51·3	44·0	22·3	25·5	34·0	27·2
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	61·7	75·0	88·6	75·1	46·6	57·1	71·2	58·3
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	24·6	..	..	..	7·2	..
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	34·7	..	..	..	17·4	..
	SERIES 3.—With Farmyard Manure.*								
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia*	26·7	−4·9	18·4	13·4	..	..	..	..

* The Increase is here taken over the produce by Farmyard Manure alone.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE VIII.—NITROGEN *recovered*, and *not recovered*, in INCREASE, for 100 supplied in MANURE.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Increase taken over the Produce without Manure.					Increase taken over the Produce by the "Mixed Mineral Manure."				
		Per-cent. of supplied Nitrogen recovered in Increase.				Average Per-cent. of supplied Nitrogen not recovered in Increase.	Per-cent. of supplied Nitrogen recovered in Increase.				Average Per-cent. of supplied Nitrogen not recovered in Increase.
		1856.	1857.	1858.	Average of 3 Years.		1856.	1857.	1858.	Average of 3 Years.	
	SERIES 1.—Without Direct Mineral Manure.										
4	200 lbs. each, Sulphate and Muriate Ammonia ..	25·7	25·7	31·6	27·7	72·3	..	..	..	..	..
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	23·9	20·6	29·1	24·5	75·5	..	..	..	..	..
6	275 lbs. Nitrate of Soda	..	..	23·8	..	..	..	..	..	..	..
7	550 lbs. Nitrate of Soda	..	..	25·8	..	..	..	..	..	..	..
	Mean	24·8	23·1	..	26·1	73·9	..	..	..	..	..
	SERIES 2.—With Direct Mineral Manure.										
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	44·0	46·7	60·8	50·5	49·5	25·6	24·9	39·6	30·0	70·0
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust ..	44·0	39·2	47·2	43·5	56·5	26·6	18·5	27·2	24·1	75·9
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat Straw	39·5	45·8	54·2	46·5	53·5	23·6	26·9	35·9	28·8	71·2
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	37·6	45·7	54·0	45·8	54·2	28·4	34·8	43·4	35·5	64·5
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	59·9	..	..	..	..	17·7	..	..
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	42·3	..	..	..	..	21·2	..	..
	Mean	41·3	44·4	54·0	46·6	53·4	26·0	26·3	36·5	29·6	70·4
	SERIES 3.—With Farmyard Manure.										
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia*	65·2	−12·0	44·9	32·7	67·3	..	..	..	..	..

* The Increase is here taken over the produce by Farmyard Manure alone.

acre, in the average annual produce of the unmanured land. Where an enormous amount of organic matter, rich in carbon, was supplied in the form of sawdust, little or no increased assimilation of carbon took place; where a still larger quantity was employed in the form of farm-yard manure (in admixture, therefore, with other active manurial matters), there was a considerable increase in the assimilation of carbon. But, under these circumstances, it is doubtful whether the farm-yard manure itself was the source of the increased amount of carbon fixed, or, at any rate, whether its supply of that substance (in the form of carbonic acid or otherwise) has been at all essential.

Thus, it was by means of mixtures of mineral manures and ammoniacal salts, without the direct supply of any carbon, that the greatest increased assimilation of that substance was obtained. For instance, on plots 10 and 13, there was an average of about 1½ tons of increase of dry substance per acre, per annum, by the use of the mixed mineral manure and ammoniacal salts. This amount of gross dry increase represents an increased assimilation of carbon, by about 12 cwts. per acre per annum, without the supply of any in the manure. To this enormous extent, therefore, have these *non*-carbon-yielding manures enabled the plants, either by their roots or their leaves, to draw that element, so essential for the maintenance of the respiration, and for the fattening of our animals, from the *atmosphere*:—into which, in the course of the ever-constant revolutions of organic nature, it had been emitted by the combustion or decomposition of the products of former vegetation, or by the respiration of animals fed on former crops:—and into which, it is destined to be returned by the same means, as the resource of future vegetable growth.

It was seen, how unavailing were *mineral manures alone* materially to increase the growth of the *Graminaceous* hay-plants. That is to say, by their supply alone, these plants were not enabled to assimilate an increased amount of either nitrogen or carbon from natural sources. Nor did the supply of one of these elements — *carbon* — enable the plants to draw from natural sources an increased amount of the other element—*nitrogen*. On the other hand, provided there were a sufficiency of the necessary mineral constituents, the supply of the element *nitrogen*, in an available form of combination, increased enormously the assimilation of the atmospheric constituent *carbon*. It may be remarked in passing, that a very similar result is observed when nitrogenous manures are employed for the *Graminaceous crops of our rotations*. Not that no other crops are found to assimilate an increased amount of carbon without its supply in manure, when they have a sufficiency of mineral constituents and available nitrogen within the soil. But compared with others, the

Graminaceous crops appear to be the most strikingly independent of any artificial carbonaceous supply.

2. *The Mineral Matter per Acre.*

The average annual yield per acre of *mineral matter* (Table V.) was, in the *unmanured hay-crop*, 158½ lbs. This, it may be observed, is about 1½ times as much as was contained in the annual *unmanured* produce of either *wheat* or *barley.*

By the use of *ammoniacal salts alone*, an average of 223½ lbs., or about 2 cwts. of mineral matter, was annually taken from the land in the hay-crop. This, again, is from 1⅓ to 1½ times as much as was removed in either wheat or barley when similarly manured; that is, by ammoniacal salts alone. By the *addition of mineral manures to the same amount of ammoniacal salts*, the quantity of mineral matter annually taken off the land in the hay-crop was increased to nearly 4 cwts. per acre. Against this amount, *farm-yard manure* gave an average of only 306¾ lbs. of mineral matter in its annual yield of hay, notwithstanding that it itself contained not only a very large amount of mineral constituents, but of nitrogen also, which is so essential to bring them into play. This comparatively defective action of the constituents of farm-yard manure is, doubtless, owing in great measure to the slow liberation of both the nitrogen and the mineral matter supplied in that form. When *ammoniacal salts* were used in *addition to the farm-yard manure*, still only 374¼ lbs. of mineral matter were annually taken from the land; that is to say, still considerably less than when the whole of both the nitrogen and the mineral matter were provided in a more readily available condition.

It is more particularly in *potash*,* that the hay-crop is more exhausting than what might be called a corresponding produce of either wheat or barley. In relation to this point, attention should be called to the fact, that, as practice goes, almost as a matter of course, a notable proportion of the phosphoric acid, and of the magnesia, almost the whole of the silica, and by far the larger proportion of both the lime and the potash, taken from the land in the *wheat* and the *barley* crops, will, at some period of the rotation, be returned to it, in the home-manures to which the straw of these crops has contributed. But, in the case of *meadow-land* associated with land under tillage, it is by no means so probable,

* Independently of the fact that an ordinary hay-crop will contain more mineral matter than the corn and the straw of an ordinary wheat or barley crop, the ash of the *hay* contains about twice as high a per-centage of *potash*, as that of the gross produce (corn and straw) of *wheat* or *barley*. But further particulars will be given regarding the *individual mineral constituents* of the hay-crop, in Part IV. of our Paper.

that the mineral constituents of the hay will, in anything like a corresponding degree, find their way back from whence they came. It will be obvious, therefore, that, according to current practice, the meadow-land will be much more liable than the arable to become deficient in a due provision of the necessary mineral constituents. These considerations show that both the wheat and the barley-crops may, with comparative impunity, be kept up to a high point of productiveness by means of forcing portable manures, provided only that the crops of the course, as a whole, receive their due share of the home manures. It will, at the same time, be equally obvious, that similar means are not applicable for the production of full crops of hay, unless similar conditions be provided; that is to say, unless the meadow, in its turn, receive a due proportion of the home manures.

Where, however, grass is grown for hay by those holding little or no arable land, it is generally for the supply of a neighbouring town; and in such cases a liberal amount of stable and other town-manures is generally brought upon the land. Under these circumstances, the additional use of the more active portable manures, will not, as a rule, be advantageous.

3. *The Nitrogen per Acre.*

Attention must now be directed to the acreage yield in the hay of the important constituent *nitrogen*. In the experiments under consideration, the annual yield of nitrogen per acre, taking the average result of 3 years, was, *without manure*, 39·8 lbs. (see Table VI.). By the side of this amount it may be mentioned, that the average of 14 consecutive years of *unmanured wheat* gave 30·7 lbs.; and that of 6 consecutive years of *unmanured barley*, 26·5 lbs. of nitrogen.

From these figures it appears, that the hay-crop (so far as the experiment has yet extended) has given from one-third to one-half more nitrogen per acre per annum, without manure, than either wheat or barley. Part of this excess of nitrogen in the hay-crop, though probably not the whole of it, is due to the fact, that the *mixed herbage* of the hay comprised a number of *Leguminous* plants, which contain a higher per-centage of nitrogen, and have apparently greater powers of assimilating it from natural sources, than the *Graminaceous* ones. Indeed, where mineral manures alone were employed (Plot 8), under the influence of which the development of *Leguminous* plants was greater than on any of the other plots, there was an average of 56·6 lbs. per acre per annum of nitrogen, without the supply of it in manure, instead of only 39·8 lbs. without manure of any kind. Thus, without the addition of any nitrogenous manure, there was

here an average annual increase of 16·8 lbs. of nitrogen per acre. But this increased yield of nitrogen obtained by the use of mineral manures, it is to be observed, was not due to an increased development of the *Graminaceous*, but to that of the *Leguminous* portion of the herbage. In fact, the annual yield of nitrogen per acre in this case, where the *Leguminous* plants comparatively so much predominated, was nearly double that which has been obtained in the continuously unmanured cereal crops of the arable land.

The next point of consideration in regard to the *nitrogen-statistics* of the *hay-crop*, is one of great interest, both in a practical and scientific point of view; namely, that of the relation of the nitrogen in the *increase*, to that in the *manure* employed to produce it. Tables VII. and VIII. illustrate this part of the subject. Table VII. shows the *actual increase* of nitrogen in the produce (in lbs. per acre), where it was supplied in manure. Table VIII. shows the *proportion* of nitrogen recovered in the increase, for 100 of it supplied in manure. But in both Tables two sets of columns are given. The first of these relates to the increase of nitrogen over that in the *unmanured* produce, and the second to the increase over that in the produce by the "*mixed mineral manure.*" The reader has thus the facts put before him in two aspects. It appears to us, however, from a careful consideration of all the circumstances of the experiments, that the only legitimate mode of estimating the amount, or proportion, of nitrogen recovered in the increase of hay, for a given amount of it supplied in the manure, will be to assume the nitrogen of the *unmanured*, and *not* that of the *mineral manured produce*, as the standard or normal yield, upon which to calculate the increase obtained by the action of nitrogenous manure, whether this be used alone, or in addition to mineral manures.

Thus, it must be remembered, that the increase, both of gross produce and of nitrogen, was, when *mineral manures alone* were employed, due to an increased development of *Leguminous* plants. On the other hand, when nitrogenous manures were used, either alone or in combination with mineral manures, the increase was due to the increased development of the *Graminaceous* herbage only. Under these circumstances, it is obvious, that the whole increase by the combined action of both nitrogenous and mineral manures (it being almost entirely graminaceous), must be supposed to be due, *so far as the resources of nitrogen are concerned*, to that artificially supplied in the manure. That is to say, bearing in mind the difference in the *description* and *composition* of the herbage grown by mineral manures alone, and by mineral manures in admixture with nitrogenous ones, the influence of the

addition of the nitrogen is not represented simply by the difference between the prominently *Leguminous* produce by mineral manures alone, and the almost exclusively *Graminaceous* produce, when nitrogenous as well as mineral manures are employed. It will be obviously much nearer the truth to assume, that the artificially supplied nitrogen—whether employed alone or in conjunction with mineral manures—was engaged in the production of *at least* the whole amount of increase *above* the produce *without manure.*

In fact, it is not impossible that, in even this mode of estimate, the degree in which the artificially-supplied nitrogen has been involved in the amount and composition of the produce, is somewhat understated. For, even the *unmanured* produce contained more of the highly-nitrogenized *Leguminous* herbage, than did that grown by either ammoniacal salts alone, or by ammoniacal salts in conjunction with mineral manure. Hence, it might be concluded, that the point beyond which the artificially-supplied nitrogen became involved in the production of *Graminaceous* increase, would be even *below* that represented by the acreage yield of nitrogen *without manure.* For, that amount depended materially upon the quantity of the highly *Leguminous* herbage in the unmanured produce, which was at once diminished on the addition of nitrogenous manures.

For the above reasons, then, it is assumed that, at least the whole of the nitrogen in the produce by nitrogenous manures *beyond that yielded on the unmanured plot* may be calculated as due, in a certain sense, to that which was artificially supplied—whether or not the nitrogen was so supplied alone, or was aided in its action by conjunction with mineral manures. At the same time, it is freely granted, that the legitimacy of any estimates regarding the proportion of the nitrogen supplied by manure which is involved in the increase obtained by its use, must rest entirely on that of the assumption made as to the amount of the whole nitrogen of the produce, which is to be attributed to natural sources. It is not, indeed, possible, to obtain actual proof, that produce grown by nitrogenous manures has really assimilated *neither more nor less* of nitrogen from other sources, than that grown without them. It might be supposed that, with a ready supply of available nitrogen within a limited range of the soil, the plants would draw less upon the natural or unaided resources. On the other hand, it might be assumed that, with the increased vigour of growth due to nitrogenous manure, the feeders of the plant would be so extended, both above and under ground, as to increase its command over the natural resources of available nitrogen. It is obvious, therefore, that the best estimate to which our judgment can lead, cannot, after all, be looked upon

as representing with certainty, the exact proportions in which the nitrogen of the manured produce has, in point of fact, been obtained from the natural and the artificial sources respectively. These observations will sufficiently indicate the degree of reservation with which the figures in the Tables, and the arguments founded upon them, should be accepted.

In regard to the figures in Table VII., which show in lbs. the *actual increase of nitrogen per acre by its use in manure*, it should be explained, that, where 400 lbs. of ammoniacal salts, or 550 lbs. of nitrate of soda, were employed per acre, it is estimated that 82 lbs. of nitrogen were thereby supplied. The 275 lbs. of nitrate of soda is, of course, assumed to supply half, and the 800 lbs. of ammoniacal salts double that amount. The 2000 lbs. of sawdust, according to direct analysis, would contain only $4\frac{1}{2}$ lbs. of nitrogen. It is, then, to these amounts of nitrogen *supplied*, that those recorded in the Table as *increase*, are to be respectively referred.

But it is in Table VIII., where the *increase* of nitrogen in the produce is, for each experiment, calculated in relation to 100 parts of it supplied in manure, that the *proportion* of the nitrogen assumed to be recovered, to that supplied, is brought to view the most clearly.

Where ammoniacal salts were used alone (see upper Division of Table VIII.), there was, taking the average of the three years, only 27·7 *per cent.* of the supplied nitrogen recovered in the increase. And where the ammoniacal salts and sawdust were used, there was somewhat less still recovered, namely, 24·5 per cent.

The nitrate of soda, which was employed in one season only, and then sown somewhat disadvantageously late, when it was used alone, returned in the increase of produce nearly the same proportion of its nitrogen as the ammoniacal salts (as just quoted)—namely, 23·8 per cent. when the smaller amount, and 25·8 when the larger amount of the salt was used. But in reference to this result, it should be mentioned, that the *percentage* of nitrogen in the hay grown by the nitrate, was notably higher than in that grown by the ammoniacal salts in the same season; in fact, the proportion of nitrogen in the former was somewhat abnormally high.

The result was, then, that where either ammoniacal salts or nitrate of soda were employed without the aid of the mineral manure, there was only about *one-fourth* of the supplied nitrogen recovered in the immediate increase of the hay-crop.

In connexion with the result just stated, attention may be called to the fact, that if, where both mineral and nitrogenous manures are employed (see lower Division of Table VIII.), the

increase of nitrogen in the produce by the use of it in manure is supposed to be represented by *so much only* as was over and above that yielded by the *mineral manures alone*, there would then appear to be only about the same proportion of the supplied nitrogen recovered as when the nitrogenous manures were used alone, and the increase of nitrogen then calculated over that in the *unmanured* crop. Thus, taking, as supposed, the yield of nitrogen by the *mineral manures alone* as the basis of the calculation, the increase obtained by the super-addition of the 400 lbs. of ammoniacal salts will have returned only 30 per cent.; that by the 400 lbs. of ammoniacal salts, and 2000 lbs. of sawdust, only 24·1 per cent.; that by the 400 lbs. of ammoniacal salts and 2000 lbs. of cut wheat-straw, only 28·8 per cent.; and that by the 800 lbs. of ammoniacal salts, 35 5 per cent., of the supplied nitrogen. In regard to the fact, that there appears to be a larger proportion of the supplied nitrogen recovered (35·5 per cent.) when the extravagant amount of 800 lbs. of ammoniacal salts per acre was employed, it may be stated that the result is due to an extremely *high percentage* of nitrogen in the produce, and not to a favourable proportion of increase. The larger return of the supplied nitrogen is, therefore, though an apparent, yet only a questionable advantage. Adopting the same mode of calculation as above, the addition of nitrate of soda to the mineral manures gave a less favourable result than that of ammoniacal salts. When 41 lbs. of nitrogen were employed in the form of nitrate, there were only 17·7 per cent.; and when 82 lbs. of nitrogen were so provided, there were only 21·2 per cent. of the supplied nitrogen recovered in the increase.

But, reckoning, as has been shown it would be more proper to do, that the whole of the nitrogen obtained by the conjoint action of the mineral and nitrogenous manures *beyond that yielded without manure*, has probably been due to that artificially supplied, the proportional return in the immediate increase then appears to be much greater. On this mode of estimation, the 400 lbs. of ammoniacal salts (with mineral manure) have returned in the increase 50·5 per cent.; the 400 lbs. of ammoniacal salts and 2000 lbs. of sawdust (with mineral manure) 43·5 per cent.; the 400 lbs. of ammoniacal salts and 2000 lbs. of cut wheat-straw (with mineral manure) 46·5 per cent.; the 800 lbs. of ammoniacal salts (with mineral manure) 45·8 per cent.; the 275 lbs. of nitrate of soda (with mineral manure) 59·9 per cent.; and the 550 lbs. of nitrate of soda (with mineral manure) 42·3 per cent., of the nitrogen supplied in the manure.

Taking the average of the results just quoted, there were about 48 per cent. of the supplied nitrogen recovered in the immediate increase of the hay-crop, when the nitrogenous manure was asso-

ciated with a liberal provision of the necessary mineral constituents. Such at any rate is the result, on the assumption that as much of the nitrogen of the produce as was *in excess of that obtained without manure*, is to be attributed to that which was *artificially supplied.* When, however, the same nitrogenous manures were employed without the aid of mineral manures, only about half as much of the supplied nitrogen appeared to be recovered in the immediate increase. There was, moreover, little more than half as much of the supplied nitrogen estimated as recovered, if, when mineral and nitrogenous manures were used together, the yield of nitrogen by the *mineral manures alone*, instead of that *without manure*, were assumed to represent the amount obtained from natural sources. But, even though the *larger* amount may more nearly represent the actual proportion of the supplied nitrogen which was recovered in the increase when mineral manures were also used, it will be, at the same time, obvious that, in a certain *practical* sense, the only *gain* of nitrogen in produce by the addition of it to mineral manures, is that amount beyond what would have been obtained by the *mineral manures alone.*

On other occasions it has been shown, that, in the growth of full crops of either *wheat* or *barley* by the direct application of nitrogenous manures, little more than 40 per cent. of the supplied nitrogen could be estimated as recovered in the immediate increase obtained. It might perhaps be anticipated, that the result would be different in the case of the *hay-crop.* Not only are but few of the plants composing it fully ripe at the time of being cut, but their roots have a much more complete possession of the whole area of the superficial layers of soil. So far as the experiments have yet extended, the *hay-crop* does not appear to return in its immediate increase, a larger proportion of the supplied nitrogen compared with *wheat* or *barley*, than might perhaps with reason be attributed to the more extended distribution of the feeders of the crop on a given area of land.

It appears, then, from the evidence as yet at command, that in the case of the *grass-crop*, as in that of the *ripened cereal grains*, a considerable proportion of the expensive constituent—*nitrogen*—which may be supplied in manure, has to be reckoned as *unrecovered* in either the immediate or the closely-succeeding increase of crop.

The possible explanations of this loss of nitrogen—real or apparent as the case may be—are numerous; but they are more or less within the reach of careful and extended experimental inquiry. It may be supposed—that a portion of the unrecovered amount of nitrogen is, in some form, drained away and lost?—that the supplied nitrogenous compound is transformed in the soil,

and nitrogen in some form evaporated?—that a portion remains in the soil in some fixed and unavailable state of combination?—that ammonia, or some other compound of nitrogen, or free nitrogen itself, is given off during the growth of the plant?—or, it may be, that the range of distribution of the supplied nitrogen, and its state of combination within the soil, are alone sufficient obstacles to its being taken up in larger proportion by the immediate crop? Should the last supposition afford a sufficient explanation of the facts observed, the assumed loss would be one but in appearance merely. The farmer might then still hope to reap the whole benefit of his costly nitrogenous manures, in the course of time, in succeeding crops. Be this as it may, the facts that have been recorded afford additional confirmation of the opinion so frequently insisted upon, that, in the case of the *Graminaceous* plants which we cultivate, a full crop is obtained only when there is a liberal provision of *available nitrogen within the soil;* and, further, that when this provision is made by means of direct nitrogenous manures, a large proportion of the so-supplied nitrogen will remain *unrecovered in the increase of crop*, at least for a considerable period of time.

The main facts elicited on a consideration of the *acreage yield* in the *hay-crop*, of some of its important *constituents*, or *classes of constituents*, according to the condition of manuring, may be summed up as follow:—

1. The average annual produce of *Total Dry Substance*, in the *unmanured meadow-hay-crop*, was about 1 ton per acre, which would contain about 900 lbs. of *carbon*. These amounts are somewhat less than were annually obtained *without manure* in either *wheat* or *barley*.

2. *Purely carbonaceous manures* did not appear to increase the assimilation by the *Graminaceous* herbage of either *carbon* or *nitrogen*.

3. *Purely mineral manures* induced little or no increased assimilation of either *carbon* or *nitrogen* by the *Graminaceous*, but a considerable amount by the *Leguminous* herbage.

4. *Specially nitrogenous manures*, such as ammoniacal salts, even when used alone, notably increased the assimilation of *carbon* and *nitrogen* by the *Graminaceous*, but not by the *Leguminous* herbage.

5. By means of manures supplying *both mineral constituents and nitrogen*, but no carbon, there was an annual increase of *Graminaceous* produce, equal to about 1½ ton of *dry substance* per acre, which would contain about 12 cwts. of *carbon*.

6. The annual yield of *mineral constituents* in the *unmanured*

hay-crop was nearly $1\frac{1}{2}$ cwt. This amount is about one and a-half times as much as was contained in either *wheat* or *barley* when *unmanured.*

7. By means of *mineral manure alone*, or *ammoniacal salts alone*, the annual yield of *mineral matter* in the hay-crop was raised to about 2 cwts. per acre; and by *mineral and nitrogenous manure combined*, to about 4 cwts. per acre.

8. It is particularly in *potash*, that the *hay-crop* is more exhaustive of soil-constituents, than either *wheat* or *barley.*

9. Owing to the comparatively large amount of *mineral constituents* taken from the land in the *hay-crop*—to the less regular return of them by the *home manures*—and to the less exposure of the soil in the case of *meadow-land*—more special attention is required to prevent *its* practical exhaustion of soil-constituents, than in the case of *arable-rotation-land.*

10. The annual yield of *nitrogen* per acre was, in the *unmanured hay-crop*, nearly 40 lbs. This is from one-third to one-half *more* than was annually obtained in *unmanured wheat* or *barley.*

11. The hay grown by *mineral manures alone*, yielded considerably *more nitrogen per acre* than that grown *without manure.* The increased amount was due to an increased growth of the *Leguminous*, and not of the *Graminaceous* herbage.

12. *Nitrogenous manures alone* (ammoniacal salts and nitrate of soda) gave an *increase of nitrogen in the produce* equal to only about *one-fourth of that supplied in the manure.*

13. *Mineral and nitrogenous manures combined* gave an *increased produce of nitrogen* equal to from 45 to 50 per cent. of the *nitrogen supplied in the manure. Wheat* and *barley*, under similar circumstances, gave an increased produce of nitrogen equal to rather more than 40 per cent. of that supplied in the manure. The rather more favourable result with the *hay-crop* is not more than is probably attributable to the more complete distribution of the under-ground feeders of the crop.

14. In the case of the *meadow-grasses*, as in that of the *Graminaceous plants grown in rotation*, the growth was much increased by *direct nitrogenous manures;* and, in both cases, from 50 to 60 per cent. of the *supplied nitrogen* remained *unrecovered* in either the immediate, or the closely-succeeding increase of crop.

Part III.—Description of Plants developed by different Manures.

Perhaps the most remarkable and interesting of the effects of the different descriptions of manure, upon the complex herbage of which the experimental meadow was composed, was the very

varying degree in which they respectively developed the different kinds of plants.

Allusion has already frequently been made, in a cursory way, to the greater development of the *Leguminous* herbage by purely *mineral manures*, and to that of the *Graminaceous* plants, or natural grasses commonly so-called, by characteristically *nitrogenous manures.* In fact, the plots had each so distinctive a character in regard to the prevalence of different plants, that the experimental ground looked almost as much as if it were devoted to trials with different seeds as with different manures. So striking and characteristic, indeed, were the effects produced in this respect, that, in 1857 and 1858, the subject was thought of sufficient interest to induce us to request the examination of the plots by Professor Henfrey, to which he kindly assented.

An endeavour was also made in the second year, 1857, to separate, and determine, the proportion of the different plants in carefully averaged and weighed samples, taken from the several plots as soon as the grass was cut. Taking advantage of the experience gained in this first trial, the separations have been carried out more carefully in the case of the produce on some of the most important plots in the third season, 1858. The results of these separations are recorded in detail in Table IX., p. 250, and in a summary form in Table X., p. 252; and it is the consideration of those results that will constitute the subject of this Third Part of our Report.

The mode of proceeding in making the separations and estimations may be shortly explained. As soon as the grass on a plot was cut down, samples were taken from many parts of it. These were carefully intermixed in such manner as to shake out as little seed as possible; and then, from the whole, a certain quantity was weighed out to be further operated upon. Characteristic specimens of each of the plants *in flower or seed*, or in other conditions in which they could be recognised, were then selected as types; and a number of boys were set to pick from the weighed sample, all they could find to correspond with these types. The remainder consisted chiefly of *detached foliage, and undeveloped stems*, which was then separated into four or five different lots, according to types selected to the best of our judgment. Each weighed sample was thus divided into from fifteen to twenty different descriptions of herbage. The weight of each of the selected portions was afterwards taken—all in an equal condition of dryness. The weights so obtained, of the respective grasses, or other plants, or parts of plants, in the original weighed sample from the plot, were then calculated into their percentage relation to the collective weight of the whole of the separated portions in their partially dried state. It is the results

so obtained that are recorded in the Tables. It should be mentioned, that we are indebted to Dr. Evan Pugh, of Pennsylvania, for the superintendence of the Botanical part of the inquiry.

It will be obvious, that absolute exactness in the determination of the proportions in which the different plants really occurred on the respective plots, would be extremely difficult to attain. If the bulk of the sample taken were so large as to exclude all possible doubt of its being a fair average of the whole produce, the labour of the separations would be so great as to be almost impracticable. There is, however, no doubt that the Tables do, in the main, very closely represent the facts. They do so, at any rate, quite sufficiently to bring very strikingly to view the most characteristic and important distinctions that were observed to be developed.

In the respective columns of the Table of detail (IX.) are given:—

1st. The Botanical names of the plants.
2nd. The Common or English names.
3rd. The *percentage proportions* of each plant, &c., on some of the most important of the experimental plots.
4th. Notes taken on a comparative examination of the specimens.

The plots selected for the Botanical analysis of their produce were:—

Plot 1. Unmanured.
Plot 4. With ammoniacal salts alone.
Plot 8. With the "mixed mineral manure"* alone.
Plot 10. With the "mixed mineral manure," and ammoniacal salts.
Plot 13. With the "mixed mineral manure" and the double quantity of ammoniacal salts.
Plot 16. With farmyard manure.
Plot 17. With farmyard manure and ammoniacal salts.

The separated plants are classified into:—

1st. Graminaceous herbage (Grasses commonly so called), in culm, bearing flower or seed.
2nd. Graminaceous herbage, detached leaf and undeveloped stem.
3rd. Leguminous herbage.
4th. Miscellaneous herbage, chiefly weeds.

Within each of these classes, the plants are enumerated in the Table, *in the order in which they respectively occurred in the largest*

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* For full description of the "*Mixed Mineral Manure*," see Part I. of this Paper, vol. xix., p. 556 of this Journal.

proportion on the unmanured plot. The comparison of the figures in the column relating to any particular *manured* plot, with those relating to the *unmanured*, thus shows at once, the deviation from the standard result which is induced by the manure in question, both as regards the *order* as to quantity, and the *actual numerical proportion*, in which the different descriptions of herbage were found to be developed.

In addition to the above explanation, it will be an useful further preliminary to the discussion of the effects of the different manures, to make a few remarks on the general character of the herbage of the experimental meadow.

In the third season (1858), to which our Table of separations refers, there was no *Dactylis glomerata* (Rough Cock's-foot), no *Poa pratensis* (Smooth-stalked Meadow-grass), no *Bromus mollis* (Soft Brome-grass), and no *Avena pratensis* (Meadow Oat-grass), detected in the produce of the *unmanured* plot. The Rough Cock's-foot and Smooth-stalked Meadow-grass occurred, however, on some of the manured plots; and each in large proportion under certain conditions of manuring. But the Soft Brome-grass, and Meadow Oat-grass, occurred in very few cases at all, and then in very small quantity. There was, too, a striking absence, on all the plots, of several esteemed permanent meadow-grasses. Thus *Alopecurus pratensis* (Meadow Foxtail), *Festuca pratense* (Meadow Fescue), *F. duriuscula* (Hard Fescue), *Phleum pratense* (Meadow Cat's-tail), and *Poa trivialis* (Rough-stalked Meadow-grass), were not found in our list at all in the third season, 1858. The Meadow Fox-tail, the Meadow Cat's-tail, and a Fescue-grass were, however, each observed on one or more of the plots in 1857.

Attention may now be directed to the comparative development of each of the plants according to the manure employed, taking each *seriatim*, in the order in which it predominated on the unmanured land. A short statement of the reputed characters of each, as to its adaptation to local conditions, and as to its recognised agricultural value, will, at the same time, be given.* The comparative development of the different *Graminaceous* plants will be first considered. The records relating to these are given in the two upper Divisions of the Table (IX.); those in the first refer to the plants *in culm*, and those in the second to the *leafy and indeterminate Graminaceous produce.*

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* See on these points, Lawson's 'Synopsis of Vegetable Products,' &c.; Bravender's 'Prize Report,' Journal of the Royal Agricultural Society of England, vol. v., part ii.; Professor Buckman's Papers, Journal of the Royal Agricultural Society of England, vol. xv., p. 462, vol. xvii., p. 162, and vol. xvii. p. 513; Donaldson 'On Manures and Grasses;' and Morton's 'Cyclopædia of Agriculture.'

EXPERIMENTS with DIFFERENT MANURE

TABLE IX.—Showing the Description and Proportions of the Different kinds c

DESCRIPTION OF THE HERBAGE.		PER-CENTAGE AMOUNTS OF EACH				
			Artificial Manures.			
Botanical Names.	Common Names.	Unmanured. (Plot 1.)	Ammoniacal Salts alone. (Plot 4.)	"Mixed Mineral Manure." (Plot 8.)	"Mixed Mineral Manure" and Ammoniacal Salts. (Plot 10.)	"Mixed Mineral Manure" and double quantity Ammoniacal Salts (Plot 13.
		1.—Graminaceous Herbage; Stem				
Lolium perenne	Common rye-grass	16·77	14·73	23·39	32·23	12·10
Holcus lanatus	Woolly soft-grass, or Yorkshire Fog.	14·02	14·43	6·94	32·64	26·37
Arrhenatherum avenaceum	Fibrous-rooted, tall oat-like grass	6·04	3·27	9·07	4·84	2·56
Anthoxanthum odoratum	Sweet-scented vernal grass	5·43	0·41	1·01	0·09	..
Agrostis vulgaris	Common or creeping-rooted bent-grass, also black switch, &c.	4·82	0·97	0·03	1·48	2·16
Briza media	Common quaking-grass	2·07	0·41	1·01	..	..
Cynosurus cristatus	Crested dog's-tail grass	1·10	0·05	0·39	..	0·05
Dactylis glomerata	Rough cock's-foot	..	1·64	..	1·38	20·17
Poa pratensis*	Smooth-stalked meadow grass*	..	..	..	..	..
Bromus mollis	Soft or downy brome-grass	..	..	..	..	0·10
Avena pratensis	Meadow oat-grass	..	..	0·34	..	1·57
	Total	50·25	35·91	42·18	72·66	65·08
		2.—Graminaceous Herbage; detache				
Leafy produce—from woolly soft-grass		3·41	12·28	5·46	4·06	15·35
Coarse leaf, &c.—some bent-grass; probably also cock's-foot, soft brome-grass, and others		8·78	11·46	1·79	6·64	3·93
Middling leaf—chiefly bent-grass; some meadow oat-grass, &c.		3·41	8·18	14·33	4·43	..
Fine leaf, &c.—unknown; possibly some Festuca bromoides, or barren fescue-grass		7·81	16·37	5·82	2·58	1·18
Dead leaves and stems		2·44	4·91	2·24	7·01	11·81
	Total	25·85	53·20	29·64	24·72	32·27
		3.—Leguminou				
Lathyrus pratensis	Yellow or meadow vetchling	2·07	2·20	4·53	..	..
Lotus corniculatus	Common bird's-foot trefoil	1·83	..	0·45	..	..
Trifolium pratense perenne†	Perennial red clover†	1·22	..	17·91	..	..
	Total	5·12	2·20	22·89	..	..
		4.—Miscellaneous Herbag				
Plantago lanceolata	Rib-grass or plantain	10·79	0·41	..	0·09	..
Carum carui	Common caraway	1·71	..	0·78	0·28	..
Achillæa millefolium	Common milfoil or yarrow.	1·34	3·58	0·48	0·28	0·59
Rumex acetosa	Sheep's sorrel or dock	0·67	1·02	0·23	0·88	1·08
Silene	Catchfly	0·61	..	..	..	..
Ranunculus‡	Crow-foot	0·49	1·13	..	..	..
Luzula campestris	Field wood-rush	0·12	..	..	..	..
Veronica chamædrys	Germander speedwell	..	..	0·22	..	..
Galium verum	Common yellow-flowered bed-straw, or cheese rennet	..	..	..	0·32	..
	Total	15·73	6.14	1·71	1·86	1·67

* With some *Agrostis*. † With some *T. repens* on Plot

on PERMANENT MEADOW LAND.

Herbage developed, according to the Manure employed. 3rd Season, 1858.

PLANT, &c. Farm-yard Manure. Alone. (Plot 16.)	PLANT, &c. Farm-yard Manure. With Ammoniacal Salts. (Plot 17.)	NOTES. Order of Luxuriance.	NOTES. Order of Ripeness.	NOTES. General Condition.
bearing Flower or Seed.				
29·00	14·92	Plots 10, 16, 17, 8, 13; 1 and 4	Plots 8 and 4; 1; 13 and 16, nearly ripe; 17, unevenly ripe; 10, rather green	On all plots more or less shedded, remaining seeds not ripe.
10·75	19·87	Plots 10, 13, 17, 16 and 4; 1; and 8	Plots 8; 16 and 17, nearly ripe; 4 and 1, greenish; 10 and 13, green	Rather green, little difference, 10 and 13 affected by bulk and laying.
14·33	17·16	Plots 17, 16, 10, 1, 8 and 4; and 13	Plots 4, ripe; 1 and 8, pretty ripe; 17, part dead ripe; 13, nearly ripe; 10 and 16, part ripe	On every plot two distinct grades of ripeness: some dead ripe, some green.
0·34	0·66	Plots 1, 8, 4, and 10, 16 and 17	Plots 17, dead ripe; 8, 4, and 10, ripe; 1, mostly ripe; 16, nearly ripe	All dead ripe, chiefly shedded.
..	1·25	Plots 1, 10, and 13; 17, 4, and 8	Plots 10, dead ripe; 8 and 4, ripe; 13, unevenly ripe; 17, greenish; 1, green	
..	..	Plots 1, 8, and 4	Plots 8; 1 and 4, ripe	All nearly ripe.
0·45	0·26	Plots 1 and 16; 17, 8, and 4 and 13	Plots 8, 4 and 13, ripe; 16, tolerably ripe; 17, middling; 1, greenish	All in full head.
..	..	Plots 13, 10, and 4	Plot 4; 10, nearly ripe; 13, greenish	Seeds not quite ripe.
14·89	10·10	Plots 16 and 17	Plots 16; 17	Generally dead ripe.
..	..	..	Ripe	Ripe.
..	0·40	..	Plots 17, dead ripe; 8 and 13, ripe	Dead ripe and mostly shedded.
69·76	64·62			
Leaves and indeterminate Stems.				
2·24	5·55			
3·58	1·32			
4·03	..			
4·48	4·22			
3·58	3·96			
17·91	15·05			
Herbage.				
2·02	1·32	Plots 8, 1, 4 and 16; and 17	Plots 1, little seeded; 4, no ripe seed; 16, in flower; 8 and 17, green and in flower	All in flower.
..	..	Plots 1 and 8	Plots 8, in flower; 1, chiefly in flower, green	In flower, plants green.
1·68	0·46	Plots 8, 16, 1, and 17	Plots 1; 17, scarcely ripe; 8, in full head; 16, some flowers, greenish	Green; chiefly in bloom; turning.
3·70	1·78			
chiefly Weeds.				
1·96	8·25	Plots 17, 1, 16, 4, and 10	Plots 4, pretty ripe; 10 and 17, nearly ripe; 16; 1, full head, not ripe	All in head, but seeds not ripe.
1·62	1·72	Plots 16 and 17, 1, 8 and 10	Plots 17; 1, seed shedding; 8, 10, and 16, ripe	All ripe.
0·22	1·78	Plots 4, 17, 1, 8, 10 and 13, and 16	Plots 13; 1 and 16, not in flower; 8 and 10, greenish; 4 and 17, green	None in flower; all green.
1·12	3·10	Plots 17, 10, 13 and 16, 1 and 4, and 8	Plots 1 and 8; 16, nearly ripe; 4 and 17, some seeded; 10 and 13, green	Some in bloom; some with ripe seeds.
..	..	..	Ripe	Ripe.
2·02	1·58	Plots 16, 17, 4, and 1	Plots 17, seed ripe; 16, in seed; 1, in seed, leaves green; 4, flowers and seed	Stems bearing ripe seed, but having green radical leaves.
..	..	..	Ripe; seeded	Ripe.
0·11	..	Plots 8 and 16	Plots 8 and 16, in flower	In flower.
..	..	..	..	Not yet in flower.
7·05	16·43			

‡ Various species.

TABLE X.—Summary of the facts given in more detail in Table IX.

	PER CENTAGE AMOUNTS OF EACH PLANT, &c.						
		Artificial Manures.				Farm-yard Manure.	
	Unmanured. (Plot 1.)	Ammoniacal Salts alone. (Plot 4.)	"Mixed Mineral Manure." (Plot 8.)	"Mixed Mineral Manure" and Ammoniacal Salts. (Plot 10.)	"Mixed Mineral Manure" and double quantity Ammoniacal Salts. (Plot 13.)	Alone. (Plot 16.)	With Ammoniacal Salts. (Plot 17.)
Total Grasses in flower or seed	50·25	35·91	42·18	72·66	65·08	69·76	64·62
Total Grasses in condition of detached leaves and indeterminate stems	25·85	53·20	29·64	24·72	32·27	17·91	15·05
Total Graminaceous herbage	76·10	89·11	71·82	97·38	97·35	87·67	79·67
Total Leguminous herbage	5·12	2·20	22·89	..	..	3·70	1·78
Total Miscellaneous herbage (chiefly weeds)	15·73	6·14	1·71	1·85	1·67	7·05	16·43
	96·95	97·45	96·42	99·23	99·02	98·42	97·88
Shedded seeds, &c., &c.	3·05	2·55	3·58	0·77	0·98	1·58	2·12
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00

I. GRAMINACEOUS HERBAGE.

1.—*Lolium perenne—Common Rye-Grass.*

This grass is reputed to be suitable to a great variety of soils, but to vary very much in character according to external conditions. It is easily propagated, is luxuriant and succulent, and yields an earlier feed than most other grasses. It is relished by stock, yields good hay, and is, in fact, one of the most generally useful of grasses. It flowers in June and July.

The grass having these reputed characters stands at the head of the list as to quantity *in culm*, not only on the unmanured plot, but on several of the others also. What proportion of the *detached leaf and undeveloped stem*, on the different plots, belonged to this grass, we were not able to determine. In the condition of flowering or seeding stem, the produce without manure contained 16·8 per cent. of it, that by purely mineral manures 23·4 per cent., that by ammoniacal salts alone 14·7 per cent., that by the "mixed mineral manure" and 400 lbs. of ammoniacal salts 32·2 per cent., and that by the "mixed mineral manure" and 800 lbs. of ammoniacal salts only 12·1 per cent. of it. Against these proportions of flowering and seeding Lolium, on the unmanured and artificially manured plots, the produce by the farm-yard manure contained 29 per cent. of it, and that by the farm-yard manure and ammoniacal salts only 14·9 per cent.

The general result in regard to the amount of Rye-grass in

flowering and seeding stem, according to manure, is as follows:— The proportion of it in the total produce was considerably increased by the "mixed mineral manures" alone, by the "mixed mineral manures" and the smaller amount of ammoniacal salts, and by the farm-yard manure alone. On the other hand, its proportion was diminished whenever the ammoniacal salts were used in relative excess; that is, when the ammoniacal salts were used alone, when they were used (with the mineral manures) in double quantity, and when they were employed in addition to the farm-yard manure. When the ammoniacal salts were used *alone*, the proportion of *Graminaceous leaf and undeveloped stem* was very high; when those salts were used in *excessive* amount with the mineral manures, the proportion of *two other grasses* (the Woolly soft-grass and the Rough Cock's-foot) predominated over that of the Rye-grass; and when the ammoniacal salts were used in addition to farm-yard manure, *three other plants* (Woolly soft-grass, Tall Oat-like grass, and Smooth-stalked Meadow-grass) seemed to gain upon the Rye-grass in degree of luxuriance.

Before passing to the next plant on the list, a few remarks may be appropriately made, which have a bearing not only on the interpretation of the results just given, but on that of those which have to follow. It must not be supposed, that figures which represent the proportion of *flowering and seeding stem* of a certain plant at one given period of the season, are at the same time accurate indications of the relative development of the *total plant* under the conditions in question. It must be borne in mind, that the numerous plants which constitute the complex herbage of our meadows, have each their natural period of flowering and seeding. This period will, however, be accelerated or postponed, as the case may be, by the external circumstances of soil, season, manure, and the association with other plants. General observation shows, that *nitrogenoüs* manures have a characteristic tendency to increase the development of *leaves and shoots* in our Graminaceous herbage. *Mineral* manures, on the other hand, induce much more the *seeding tendency*. With full supplies of mineral manures, therefore, we should expect (other conditions being favourable) that there would be a larger proportion of the growing plant in culm, at a given period, than when ammonia was supplied in relative excess. The general result was, indeed, that the proportion of the total Graminaceous plants which was *in culm*, was the greater where the mineral supplies predominated, and the proportion in leaf and undeveloped stem the greater when ammoniacal salts predominated. Hence, the effect of a manure on the development of the *total plant*, cannot be determined unconditionally by the proportion found in flowering and seeding stem.

The evidence is, nevertheless, sufficiently clear, that the bulky, luxuriant, and generally useful *Rye-grass*, was considerably developed by high artificial manuring, when this supplied a sufficiency of mineral constituents, and a pretty full, but not excessive, amount of nitrogen. But when ammoniacal salts were used in addition to farm-yard manure, the proportion of the Rye-grass appeared to be diminished. It will be afterwards seen, that this result was due to the fact, that two other grasses (Tall Oat-like grass, and Smooth-stalked Meadow-grass), which occurred either in comparatively small proportion, or not at all, on the other plots, were very considerably developed by the farm-yard manure.

2.—*Holcus lanatus—Woolly Soft-Grass, or Yorkshire Fog.*

This grass is said to be natural to damp and peaty soils; to give a considerable amount of after-math, but not to be liked by cattle either when green or in hay, being too soft, spongy, and insipid. In fact, some consider it as almost a weed. It is further said, to usurp the land in sandy soils, not to be reduced by cultivation, and to have the tendency to banish the artificial grasses. It flowers in July.

Such are the characters of the grass which was found second in amount among those in *culm*, on the unmanured land. It occurred, however, in larger proportion still on some of the manured plots. A considerable proportion of the *leafy* produce was also referred to this plant. The Woolly soft-grass, in the condition of flowering and seeding stem, constituted 14 per cent. of the produce without manure, 6·9 per cent. of that by mineral manures alone, 14·4 per cent. of that by ammoniacal salts alone, 32·6 per cent. of that by the mineral manures and 400 lbs. per acre of ammoniacal salts, and 26·4 per cent. of that by the mineral manures and the 800 lbs. of ammoniacal salts. Lastly, in the produce by farm-yard manure alone, the proportion was only 10·7 per cent., and in that by farm-yard manure and ammoniacal salts 19·9 per cent.

The general result was, that the proportion of the Woolly soft-grass was very much increased by nitrogenous manures. The effect was the more apparent when the leafy portion of the produce attributed to this plant was taken into the calculation. In fact, it is those artificial manures which developed the largest proportions of *total Graminaceous herbage*, that yielded the largest amounts of this grass. It amounted, culm and leaf together, to more than a quarter of the total produce when ammoniacal salts were used alone, to nearly 40 per cent. of it when the mineral manures and the 400 lbs. of ammoniacal salts were employed, and to more than 40 per cent. of the total produce when

the mineral manures and the 800 lbs. of ammoniacal salts were used. The proportion of the whole which was in the condition of leaf and undeveloped stem, was much the greatest where the ammoniacal salts were in relative excess; that is to say, when those salts were either used *alone*, or in the *double quantity with the mineral manures.* Where farm-yard manure was employed the Woolly soft-grass, like the Rye-grass, as mentioned above, appeared to be somewhat displaced in its proportion by the predominance of two other grasses (Oat-like grass, and Smooth-stalked meadow grass), to which further reference will be made presently. Still, by the addition of ammoniacal salts even to farm-yard manure, the proportion of the Woolly soft-grass was considerably increased.

This Woolly soft-grass, and the Rye-grass together, constituted about one-third of the total produce without manure; they together made up more than two-thirds of that by the mineral manures and the smaller amount of ammoniacal salts; and more than half of that by the mineral manures and double amount of ammoniacal salts.* Upon the whole, it appears that, although the Rye-grass is much increased by nitrogenous manures, the Woolly soft-grass is even more characteristically so; the latter, at the same time, seems less dependent on a coincidently liberal supply of mineral constituents. So far, therefore, as the relative development of these two plants is concerned, the character of the herbage would be the better when the supply of nitrogen in the manure was not excessive, and that of mineral constituents liberal.

It is quite consistent with the character given to the Woolly soft-grass—namely, that it tends to usurp the land and is not reduced by cultivation—that the manures which give the greatest increase in the produce of hay should give so large a proportion of this ill-reputed element. If, indeed, this grass be really so objectionable as it has been stated to be, it would appear to be very desirable carefully to exclude it from the seed in laying down grass-land; otherwise—soil and other circumstances being adapted to its growth—the higher the manuring, and the larger the crop, the greater will be the proportion in it of this ill-famed plant.

3.—*Arrhænatherum avenaceum—Fibrous-rooted, tall Oat-like Grass.*

The reputed characters of this grass are, that it yields a considerable quantity of foliage on the culms, which affords a good

* Under this very excessive manuring, the Rye-grass appeared to be somewhat displaced in its proportion by the rough Cock's-foot, which on that plot, and on that alone, was very luxuriant.

deal of leafy feed in the spring. It is said to reproduce rapidly after cutting. Its taste is rather bitter, but it is not disliked by cattle. It does not grow abundantly except upon poor soils, and is upon the whole of somewhat questionable value; it is, however, much grown in France. Its time of flowering is May.

This grass (in culm, &c.) stood third in amount on the unmanured land; it there constituted, however, only 6 per cent. of the total produce. Purely mineral manures raised its proportion to 9 per cent. Ammoniacal salts, on the other hand, whether alone or in admixture with the mineral manures, seemed adverse to its predominance. Its proportion with such manures (see Plots 4, 10, and 13) was less than on the unmanured land. With farmyard manure, as with mineral manures, the proportion of the Oat-like grass was, as already alluded to, considerably increased. In fact, when the farmyard manure was used alone, the proportion of this grass in the total produce was more than double; and when with the addition of ammoniacal salts, about three times as great as it was on the unmanured plot.

The general conclusion to be drawn regarding the relative development of this grass, when grown in a mixed herbage, would seem to be, that, with high artificial manuring of the kind that meadow-land is most likely to receive, it would not by such means alone be increased, but more probably diminished in its proportion in the total produce. But when farmyard manure is liberally used, or the soil is comparatively rich in mineral constituents, its development would appear to be encouraged. The result may be due, either to the special adaptation of rich mineral manuring to the luxuriant development of this grass, or to the fact that, with highly nitrogenous manures, its growth is somewhat checked by the greater luxuriance of the freer-growing grasses.

4.—*Anthoxanthum odoratum*—*Sweet-scented Vernal Grass.*

It is to the presence of this grass that the peculiar fragrance of newly-made hay is due. Its foliage is broad and coarse, but the plant is a scanty grower, though most luxuriant on wet soils. It is not relished by cattle, but is not objected to in small proportion; it is said to be best adapted for sheep. Upon the whole this grass takes rank somewhat low in the scale of the better grasses for permanent purposes. It flowers early, namely, in April and May.

Our separations showed $5\frac{1}{2}$ per cent. of the Sweet-scented Vernal-grass (in culm), in the produce of the unmanured land. There was only one other instance—namely, that where mineral manures were used alone—in which the proportion amounted to 1 per

cent. The highly nitrogenous artificial manures appeared to be very adverse to its growth, nor did it succeed much better with farm-yard manure. As, however, this grass is a very early one, it is possible that, at the time of cutting, some of it would be past the stage at which it would be recognised in our samples.

The general result was, that the growth of the Sweet-scented Vernal-grass was much discouraged by such manures as greatly increased the amount and proportion of the Graminaceous hay-plants as a whole. Whether this is of consequence in any other point of view than that of fragrance, and whether in this one it is of real practical importance, is, perhaps, a question.

5.—*Agrostis vulgaris—Common, or Creeping-rooted Bent-Grass, or Black-switch, &c.*

This grass is said to flourish most on dry soils, to be a troublesome weed on arable land, to be disliked by cattle, and also by sheep, excepting sometimes in winter. It is, in fact, reputed as useless, and is recommended to be discouraged as much as possible. The time of flowering is May.

This grass amounted, in culm, to nearly 5 per cent. in the produce without manure. The proportion was, however, very much reduced under every one of the manured conditions. This result is certainly not to be regretted, if the characters of the grass are fairly given, as above. However, the *detached leaf and undeveloped stem* set down in the Table as "middling," was supposed to consist chiefly, and that set down as "coarse" more or less, of Bent-grass; and if this estimate be correct, it would appear, that there was a considerable proportion of this grass in this undeveloped condition on most of the plots; though it would be least in amount where either the farm-yard manure or the mixtures of mineral manure and ammoniacal salts were employed. Fortunately, then, a grass having such a bad character as is attributed to the creeping-rooted Bent-grass seems to meet with the desired discouragement in those manures which develop more freely its more valuable congeners.

6.—*Briza media—Common Quaking-Grass.*

This grass is reputed to thrive best on poor soils, to afford a small yield, not to be liked by cattle, and to be discouraged by manuring. It flowers in June.

The Quaking-grass amounted to 2 per cent. in the sample of the produce from the unmanured land. It was only found in two cases in the manured produce, and then in even less proportion than in the unmanured. In the most highly-manured produce none whatever of it was to be found. The reduction or entire exclusion by manuring, is consistent with the character

of this grass as given above. It would seem, therefore, that it is not likely to be troublesome on good land, and that it is easy of expulsion by good manuring.

7.—*Cynosurus cristatus—Crested Dog's-tail Grass.*

This grass is said to have a wide range of soils, to grow on dry, damp, and even irrigated lands, and to vary in character accordingly. The opinions given respecting its value are somewhat conflicting. Some authorities consider its root-leaves, which are comparatively abundant, to be a favourable food for sheep, and that it is useful on soils and in seasons when other grasses are deficient. The stems seem, however, not to be eaten at all; and the more recent opinions, especially those of Professor Buckman, are quite against its utility. It is said, however, to be better for pasture than for hay; but as its character is to die out by improvement, its perhaps now established inferiority need not be much regretted. The time of flowering is June and July.

This crested Dog's-tail grass stood lowest of any among the grasses, in the scale of quantity on the unmanured land. It there amounted, in culm, to only 1 per cent. of the total produce. It was found in the manured produce in less proportion still, especially where ammoniacal salts were used. It would appear, therefore, that where such manuring is employed as greatly increases the produce of hay, there will be little or none of this doubtfully useful element.

8.—*Dactylis glomerata—Rough Cock's-Foot.*

The Rough Cock's-foot is said to be very abundant and productive on good soils, particularly on those of a clayey nature, and to be much improved by cultivation. It grows well in moist and shady places, has broad foliage, is tufty, and reproduces rapidly after cutting. All stock like it, but particularly sheep, early in the season, before it has become hard and coarse. Its time of flowering is June and July.

Of this grass, in the condition of flowering and seeding stem, none whatever was found in the sample taken from the unmanured plot; none in that from the mineral manured plot; and none in that from either of the plots manured with farm-yard manure. It would appear, however, from the notes made by Professor Henfrey on the growing crop of 1857, as well as from the results of the partial separations made by ourselves when the crop of that year was cut, that the Rough Cock's-foot was far more predominant in the second than in the third year of the experiment. The conditions of growth of the samples in which it was found in the third year, are consistent with its apparent exclusion under

the conditions mentioned above. It was found to the amount of less than 2 per cent. (in flowering and seeding stem) in the sample grown by ammoniacal salts alone, in less than $1\frac{1}{2}$ per cent. in that by the same amount of ammoniacal salts with mineral manures in addition, but to the extent of 20 per cent. when the double or excessive amount of ammoniacal salts, together with the mineral manures, were employed. Where this very large proportion of Rough Cock's-foot was found in the produce of 1858, it was set down by Professor Henfrey in 1857, as "very fine," "abundant," and "ripe," and in the other cases as "backward." Consistently with this order of development of this plant according to manuring, we find a very small proportion of that leafy produce (the coarse) which was estimated to contain Cock's-foot, where the amount in flowering and seeding stem was so large, but more where the amount in flowering and seeding stem was only small. There was the most of it where the ammoniacal salts were used alone; and it was in the sample of "coarse" leafy produce grown by that manure, that Professor Henfrey concluded there was the most of the Cock's-foot.

It appears that characteristically nitrogenous manures are favourable to the predominance of the Rough Cock's-foot. Where the supply of nitrogen is only moderate, it would appear to be outgrown and overpowered by the Rye-grass and Woolly soft-grass. It, in its turn, appears to overpower, particularly the Rye-grass, when the nitrogenous manure is very abundant. And, under the same conditions, it seems to reduce, and almost to exclude, several of the grasses of less value, and of less free growth. Thus, when the Cock's-foot was so abundant, there was less of the Oat-like grass found than on any of the other plots, no Sweet-scented Vernal-grass, very little creeping Bent-grass, no Quaking-grass, and scarcely any crested Dog's-tail. The reputed characters of the Rough Cock's-foot given above, are consistent with this luxuriant growth under high manuring, and with this apparent tendency to push out other plants by its own active vegetation. The Cock's-foot also affords an example of a useful grass much developed by those manures which yield a great bulk of total produce.

9.—*Poa pratensis—Smooth-stalked Meadow Grass.*

The Poa pratensis is said to be rather particular in its choice of situation, not to relish damp soils, but to thrive well in good and rather dry ones. It grows tuftily, and is said to have the tendency to banish other grasses. Its character is to yield a good early feed, and a free-growing and hardy after-grass. It flowers in May and June.

This grass was found only in the samples of the produce

grown by farm-yard manure. In these, however, its proportion was very considerable, amounting to about 15 per cent. of the whole where the farm-yard manure was used alone, but to only 10 per cent. where the farm-yard manure and ammoniacal salts were used together. From our records relating to the produce of the second season, it appears that this Smooth-stalked Meadow-grass was detected on more of the plots in that season than in the third. Still, even then, it was found in very much larger proportion in the produce grown by farm-yard manure than in that by any of the other manures. This very marked development almost exclusively by farm-yard manure might lead to the conclusion, that part of the result was due to seed brought upon the land by the dung. But that the character of the manure, as such, had much to do with the effect, would seem from the fact, that the proportion of the Smooth-stalked Meadow-grass was considerably reduced when ammoniacal salts were used in addition to farm-yard manure.

It would appear that the Smooth-stalked Meadow-grass is particular in the choice of manure as well as situation, and that artificial nitrogenous manures are either directly obnoxious to it, or cause it to be pushed out by those grasses whose luxuriance is greatly stimulated by such manures. Nor was this Poa perceptibly favoured in its growth by purely mineral manures. It might be supposed, therefore, that the carbonaceous organic matter of the farm-yard manure had something to do with the greatly increased development of the plant under the influence of that manure. This greatly increased development of the Smooth-stalked Meadow-grass under the influence of farm-yard manure appeared to be chiefly at the cost of the Woolly soft-grass —an exchange not at all to be regretted. The Oat-like grass is another grass much more valuable than the Woolly soft-grass, the proportion of which was much increased by farm-yard manure. This manure was seen, therefore, to develop two better grasses at the expense of a worse one. But it is to be regretted, that so useful a grass as the Smooth-stalked Meadow-grass should appear to be so nearly excluded under the influence of those so-called artificial manures, which are practically the most useful in increasing the produce of Graminaceous hay.

10.—*Bromus mollis—Soft or Downy Brome-Grass.*

This grass is described as a common weed in grass-land, the seed of which should be carefully excluded when sowing down. It is said to be innutritious, and even injurious to some animals. It flowers early in the season, but, after cutting, often seeds in the after-grass. It is found most in poor exhausted pastures.

With such characters as are here given to this grass, it is not

to be regretted that it was found in only one of our samples, and there in very small proportion. Professor Henfrey was, however, of opinion that its leaf occurred in a few of the samples of the "coarse" leafy produce.

11.—*Avena pratensis—Meadow Oat-Grass.*

This grass is best adapted to dry heathy places. It is of doubtful feeding value, though conflicting opinions are given respecting it. But, as it is said to be soon got rid of by good cultivation, its qualities are perhaps not of much consequence. It is the last on our list of *flowering and seeding Graminaceous plants.* It was found in the samples from three only of the seven plots, and in those in but insignificant amount. The largest quantity was found in the sample grown by the mixture of mineral manure and the excessive amount of ammoniacal salts.

There are two other items to be briefly noticed before closing this *seriatim* account of the different descriptions of *Graminaceous* herbage found in the produce of the respective plots.

The proportion of the *leafy* produce set down in the Table as "*fine*," varied extremely according to the manuring. It was very large where the ammoniacal salts were used *alone;* and moderately so on the other plots where the total produce was not very large; but very small in the samples from the heaviest crops. We were quite unable to determine with any certainty to what plant or plants this "fine" leafy matter was to be referred. Professor Henfrey was, however, of opinion that some at least belonged to *Festuca Bromoides*, or Barren Fescue-grass.

"*Dead leaf and stem*" is the last item in the list of *Graminaceous* produce. Contrary to the fine leaf, this worthless dead matter occurred in very far the largest proportion where the artificial manuring was the highest, and the crops were the heaviest. Where the mineral manure and excessive amount of ammoniacal salts were employed, this damaged portion of the produce amounted to nearly 12 per cent. of the whole; and where the mineral manure and the more moderate amount of ammoniacal salts were supplied, to 7 per cent. Here, then, is experimental evidence showing a practical disadvantage in manuring so highly as to cause the crop to fall and die at the bottom before the bulk is fit for cutting.

II. Leguminous Herbage.

In the second season, 1857, four descriptions of Leguminous plant were distinguished on the experimental plots. These were *Lathyrus pratensis* (Yellow or Meadow Vetchling); *Lotus cornicu-*

latus (Common Bird's-foot Trefoil) ; *Trifolium pratense perenne* (Perennial Red Clover) ; and *Trifolium repens* (White or Dutch Clover). In the third season, 1858, very little of the last mentioned plant (Dutch clover) was observed on any of the plots ; and the three other Leguminous plants seemed to be confined to fewer plots than formerly. Their limitation, or extension, according to manuring, is very striking ; and it is to the degree and conditions of their distribution, that attention is now to be directed. The results relating to these points are given in the third Division of Table IX.

1.—*Lathyrus pratensis—Yellow or Meadow Vetchling.*

This plant is described to grow naturally on either moist or dry soils, but generally on such as are of good quality. Cattle generally eat it with avidity ; and hence it is recommended to be grown on very dry soils. The creeping nature of its roots unfits it for growth in rotation, but not so much for permanent meadow. It flowers in July.

The Meadow Vetchling occurred in rather larger proportion than either of the other Leguminous plants on the unmanured land. It there amounted, however, to only 2 per cent. of the total produce. On the *mineral manured plot* its proportion was raised to $4\frac{1}{2}$ per cent. ; and on the plot with ammoniacal salts alone, there were about $2\frac{1}{4}$ per cent. In the produce by the mineral manure and ammoniacal salts together, none of this plant was observed. The produce by farm-yard manure gave about 2 per cent., and that by farm-yard manure and ammoniacal salts little more than 1 per cent. of the Meadow Vetchling.

2.—*Lotus corniculatus—Common Bird's-foot Trefoil.*

This plant is said to grow abundantly on dry elevated pastures, and heathy soils ; and to be well deserving of cultivation on light, dry, elevated inferior soils, on which it will yield a greater bulk of herbage than any of the cultivated clovers. It is supposed to be highly nutritious, and is eaten with avidity by cattle. From the great depths to which its roots penetrate, it is not liable to be injured by drought, and is hence enabled to retain its verdure after the grasses and other plants are burnt up. It flowers from June to August.

The Bird's-foot Trefoil was found in the produce of only two of the experimental plots, namely, the *unmanured*, and the *mineral-manured* ones.

3.—*Trifolium pratense perenne—Perennial Red Clover.*

There are several varieties of this plant, of which the most important are the Native perennial Red Clover, and the Common

perennial Red Clover or Cow-grass. They are too well known to every farmer to require description here.

Perennial Red Clover amounted to little more than 1 per cent. of the total produce on the *unmanured* land, but to nearly 18 per cent. of that grown by *mineral manures alone.* Not any of it was found in the produce by either ammoniacal salts alone, or ammoniacal salts in conjunction with mineral manures. There was little more than $1\frac{1}{2}$ per cent. of it in the produce by farm-yard manure alone, and less than $\frac{1}{2}$ per cent. in that by farm-yard manure and ammoniacal salts.

The proportion of *total Leguminous Herbage* found in the produce of the *unmanured* plot, was about 5 per cent. This was made up of two parts Meadow Vetchling, rather less than two parts Bird's-foot Trefoil, and rather more than one part Perennial Red Clover. The produce by *mineral manures alone* was estimated to contain about 23 per cent. of Leguminous herbage, or about $4\frac{1}{2}$ times as high a proportion as that grown without manure. These 23 parts comprised about $4\frac{1}{2}$ parts Meadow Vetchling, about $\frac{1}{2}$ a part of Bird's-foot Trefoil, and about 18 parts of Perennial Red Clover = 15 times as much as was found of it in the unmanured produce. The *ammoniacal salts alone*, *reduced* the proportion of total Leguminous plant to little more than 2 per cent. in the produce, and then it consisted entirely of Meadow Vetchling: the Bird's-foot Trefoil and the Perennial Red Clover being apparently extirpated. And, in the produce by *mineral manures and ammoniacal salts together*, *not any* Leguminous plant was to be found. The *farm-yard manure produce* contained less than 4 per cent. of Leguminous plant, which consisted of nearly equal parts Meadow Vetchling and Perennial Red Clover, to the exclusion of the Bird's-foot Trefoil. The *addition of ammoniacal salts* to farm-yard manure, *reduced* the proportion of Leguminous herbage to about one-half. There was still no Bird's-foot Trefoil; and the Perennial Red Clover, as before, gave way more than the Meadow Vetchling under the influence of the ammoniacal salts.

III. Miscellaneous Herbage, chiefly Weeds.

The fourth Division of the Table shows, that there were nine descriptions of these questionably useful, or even objectionable plants, detected in the samples from the experimental plots. Only seven of them were found together on the unmanured land, and a smaller number still on each of the manured plots. A few remarks will be made upon the characters, and conditions of occurrence, of these several plants, taking them in the order in which they occurred in the largest proportion on the unmanured land.

1.—*Plantago lanceolata—Rib-grass or Plantain.*

This plant is reputed to yield an herbage which, early in the season, is eaten by cattle, horses, and sheep; but which is disliked by them as the season advances. It is also objectionable on account of its spreading leaves, which tend to exclude other plants. It is natural to dry pastures. It flowers in June and July.

Nearly 16 per cent. of the produce *without manure* consisted of *Miscellaneous Weedy herbage.* This comprised seven descriptions of plant, yet nearly 11 out of the 16 parts consisted of the Rib-grass. None of it was found in the produce grown by mineral manures alone; scarcely any in that by ammoniacal salts alone; less still in that by the same amount of ammoniacal salts and the mineral manures; and none at all in that by the double amount of ammoniacal salts and the mineral manures. On the farm-yard manure plot less than 2 per cent. of the total produce, or only about one-sixth as much as on the unmanured land, consisted of the Rib-grass. The addition of ammoniacal salts to the farm-yard manure, however, greatly increased the proportion of Rib-grass in the produce—namely, to 8¼ per cent.

It appears, then, that the Rib-grass, which was so prominent an item on the unmanured land, was greatly reduced in its proportion by farm-yard manure and ammoniacal salts; still more by farm-yard manure alone; and nearly or entirely excluded by those artificial manures which increase the most the total produce of hay, and especially that of the Graminaceous herbage.

2.—*Carum carui—Common Caraway.*

This plant, though second in amount among the Miscellaneous Weedy herbage on the unmanured land, amounted there to less than 2 per cent. of the total produce, and to about the same proportion in the produce of the two farm-yard manure plots. It was much diminished in its proportion, or excluded altogether, by the purely-artificial manures, especially when ammoniacal salts were in relative excess.

3.—*Achillæa millefolium—Common Yarrow or Milfoil.*

The Milfoil is stated to be a grateful element in small admixture with other herbage for sheep; and it is recommended, therefore, to be sown with other seed for permanent sheep-pasture.

The Milfoil was found to the amount of somewhat more than 1 per cent. in the produce without manure. Its proportion was much diminished by farm-yard manure alone, mineral manure alone, and the mixtures of the mineral manure and ammoniacal salts. Where the larger amount of ammoniacal salts was used (with mineral manure) both the proportion and the actual

amount of this plant were considerably greater than where the smaller amount was employed with the mineral manures. Consistently with this effect of ammoniacal salts, the proportion of the Milfoil was very much increased by the addition of these salts to farm-yard manure ; and it was the greatest—in fact, then nearly three times as great as without manure—where the ammoniacal salts were used alone.

If the characters of the Milfoil as sheep-food be such as above-described, it need not perhaps be much regretted that its growth seems to be favoured by nitrogenous manures.

4.—*Rumex acetosa—Sheep's-sorrel or Dock.*

This plant is undoubtedly objectionable. Unfortunately, however, it, as well as the Milfoil or Yarrow, was found in the produce of every plot ; and, like the latter, it was increased in its growth by the use of ammoniacal salts. It was more or less increased by these salts in whatever combination they were employed. Farm-yard manure alone also notably increased the proportion of the Dock in the produce ; but farm-yard manure and ammoniacal salts together increased it still more. With the latter combination the Dock amounted to more than 3 per cent. of the produce. As this obnoxious plant seems to be favoured in its growth by manuring, its expulsion must be attained by other means.

The remaining five plants that were detected in the samples are, without doubt, useless, if not obnoxious. They were each found, however, only on a few of the plots, and generally in but insignificant proportion.

5.—*Silene, or Catch-fly,*

was found in the unmanured produce only, and there to the extent of little more than $\frac{1}{2}$ per cent.

6.—*Ranunculus—Crow-foot* (various species).

These plants were found in small quantity in the produce from the unmanured plot ; in larger proportion in that grown by ammoniacal salts alone ; and in larger proportion still on the two plots with farm-yard manure. Their growth was, however, very much discouraged by the most productive artificial manures.

7.—*Lazula Campestris—Field Wood-rush.*

This rush was found only in the sample from the unmanured land, and there in very insignificant amount.

8.—*Veronica chamædrys*—*Germander Speedwell*—
was found only in the produce by mineral manures alone, and by farm-yard manure alone; and in both cases in very small amount.

9.—*Galium verum*—*Common Yellow-flowered Bed-straw, or Cheese-rennet.*

This plant was only found in the sample grown by the mixed mineral manure in conjunction with the lesser quantity of ammoniacal salts.

It is possible that there were some other plants that either did not come within the reach of the scythe, or were otherwise excluded from our samples or determinations. Nor are the exact numerical proportions set down in the Table, to be considered, either within this or the other classes of plants, as anything more than approximations. Such, however, they undoubtedly are; and the facts brought out regarding the distribution, and development, of Miscellaneous Weedy herbage, according to manure, are very clear and striking.

From this examination the very satisfactory result appears, that by far the larger *number* of the obnoxious or comparatively-useless plants occurred in the produce of the *unmanured* land. Taken collectively, too, their *proportion* was there very much larger than under any of the other conditions, excepting the one where the farm-yard manure and ammoniacal salts were used together. It was chiefly the Rib-grass, and the Sheep's-sorrel or Dock, that were encouraged by this latter manuring. The *farm-yard manure alone* gave a larger proportion of Weedy herbage than any of the *artificial manures;* but not half as much as either the *unmanured* land, or that manured by *farm-yard manure and ammoniacal salts.* On all the artificially-manured plots the *number* of species found was reduced to about half that occurring on the unmanured land. In fact, those artificial manures which were the *most productive*, not only reduced the number of species of weeds considerably, but reduced the proportion of the total of such produce to about *one-tenth as much* as was developed *without manure.* It is certainly very satisfactory to find, that the most active artificial manures had the effect of very greatly *reducing* the proportion of the useless and obnoxious plants in the mixed herbage of the meadow. It is, on the other hand, somewhat discouraging to find, that the influence of *farm-yard manure*, which must be relied upon for the hay-crop to a certain extent, was not so favourable. It is to be hoped, that the facts which have been adduced regarding the conditions of development, and the amounts, of the Miscellaneous Weedy herbage on the meadow

land, may fix on the mind of the farmer, the clear idea which the discussion of actual figures conveys, of the real amount of objectionable produce which he may frequently grow, unless proper means of reduction or eradication be had recourse to.

Attention may now be turned from the detailed consideration of the circumstances of development of the *individual plants*, to a statement of the more general character of the herbage under the different manurial conditions. In the Summary Table X. (p. 252) are recorded the main facts necessary to such a review; and the most prominent results already noticed in their place in more detail, will supply the remainder.

1.—*Total Graminaceous Herbage.*

At the time of cutting, 76 per cent. of the produce without manure consisted of Graminaceous herbage. At the same period of time, the proportion of such herbage in the total produce was increased to about 87¾ parts by farm-yard manure alone, and to 79¾ parts by farm-yard manure together with ammoniacal salts. The produce by mineral manures alone contained scarcely 72 per cent. of Graminaceous herbage; 4 per cent. less, therefore, than the produce without manure. On the other hand, the produce by 400lbs. of ammoniacal salts per acre, contained 89 per cent.; that by the same amount of ammoniacal salts and mineral manures, 97⅓ per cent.; and that by the double amount of ammoniacal salts and the mineral manures, also, 97⅓ per cent. of Graminaceous herbage.

But the *Graminaceous produce itself* varied extremely in character according to the manure employed. At a given period of the season, the Graminaceous herbage grown without manure, consisted of 66 per cent. of flowering or seeding stem, and 34 per cent. of leaf and undeveloped stem. At the same period, the Graminaceous produce by farm-yard manure, comprised nearly 80, and that by farm-yard manure and ammoniacal salts, rather more than 80 per cent., of culm, in flower or seed. Against these amounts without manure, or by farm-yard manure, the Graminaceous produce grown by the artificial manures alone was composed as follows:—That by the mineral manures alone contained 59 per cent. of flowering and seeding stem; that by ammoniacal salts alone, only 40 per cent.; that by the same amount of ammoniacal salts and mineral manure, 75 per cent.; and that by the double amount of ammoniacal salts and mineral manure, 67 per cent., in flowering and seeding culm.

The general result is, *that those manures which much increased the produce of hay, at the same time very much increased*

its proportion of Graminaceous herbage. In fact, where the largest crops were obtained, namely, where the mixed mineral manure and ammoniacal salts were used together, the proportion of the whole produce that was Graminaceous, was more than 97 per cent., whilst that without manure was only 76 per cent. The characteristic effects of nitrogenous manures to increase the proportion of leaves and shoots, and of mineral manures to determine more to flowering and seeding, are also strikingly illustrated. It will be obvious, therefore, that not only must the character of the gross produce be very different according to the description of manure employed, but that the proper time of cutting must vary very considerably to secure the majority of the herbage at any given point of ripeness.

But it has been seen, that the Graminaceous herbage varied much in character according to the manure, not only in regard to its proportion in the total produce, and to the proportion of the whole that was leafy and stemmy respectively, but also in the description or species of plants developed.

Under the particular conditions of soil, season, original distribution of plants, and other circumstances of these experiments, common Rye-grass was the most predominant of the grasses in the unmanured produce. The inferior Woolly soft-grass occurred in nearly an equal quantity; and then succeeded in lesser quantities, in the order here given, the tall Oat-like grass, the Sweet-scented Vernal-grass, the Creeping-rooted Bent-grass, the common Quaking-grass, and the Crested Dog's-tail—the last in very small amount. Farm-yard manure, which increased the actual amount and proportion of total Graminaceous herbage, gave a considerably increased proportion of Rye-grass and of tall Oat-like grass; a somewhat diminished proportion of the Woolly soft-grass; scarcely any of the other grasses found on the unmanured plot; but a very large amount of the valuable Smooth-stalked Meadow-grass, which was not found at all in the produce without manure. The addition of ammoniacal salts to the farm-yard manure diminished the proportion of the more valuable Rye-grass, and Smooth-stalked Meadow-grass, but increased that of the tall Oat-like grass, and that of the inferior Woolly soft-grass.

Leaving out of consideration here, those artificial manures which did not much increase the total produce of hay, namely, the mixed mineral manure used alone, and the ammoniacal salts alone, the general result with the more active artificial combinations was as follows:—The mixed mineral manure with the more moderate amount of ammoniacal salts gave about 2½ times as much produce as the unmanured land, and the proportion of it that was Graminaceous was more than 97 per cent., instead of only 76 per cent. without manure. This enormously-increased Grami-

naceous produce contained twice as high a proportion of both the valuable Rye-grass, and the inferior Woolly soft-grass, as that without manure. The proportion of the Oat-like grass was, on the other hand, diminished; and, under the same conditions, all the other grasses were either very much reduced, or entirely excluded.

When the double and excessive amount of ammoniacal salts was employed (with the mineral manure), the produce was about $2\frac{3}{4}$ times as much as on the unmanured land, and the proportion of it that was Graminaceous was, as in the last case mentioned, more than 97 per cent. This greatly-increased Graminaceous produce, under the influence of an excess of ammoniacal salts, contained a smaller proportion of the common Rye-grass than the unmanured hay. On the other hand, the proportion of the inferior Woolly soft-grass was very much increased. There was, moreover, with this manure a very large proportion of Rough Cock's-foot—a grass which was found on very few of the other plots, and then in very small proportion. All the other grasses were either excluded, or much reduced in amount, under the influence of this excessive manuring.

2.—*Total Leguminous Herbage.*

The proportion of Leguminous herbage in the total produce without manure was about 5 per cent. Farm-yard manure reduced the proportion, but not the acreage amount, of such produce; and the combination of farm-yard manure and ammoniacal salts, very considerably reduced both the actual amount, and proportion, of this kind of herbage. In the produce by those artificial combinations (mineral manure and ammoniacal salts), which more than doubled or nearly trebled the amount of hay, and which increased the amount and proportion of the Graminaceous herbage so strikingly, not a trace of Leguminous herbage was found. Again, ammoniacal salts alone, which notably increased the Graminaceous herbage, almost excluded the Leguminous. In the produce with this manure, neither Bird's-foot Trefoil nor Perennial Red Clover was found; but the Meadow Vetchling occurred in about the same proportion as in the unmanured produce. On the other hand, mineral manures alone, which gave little or no increase of Graminaceous produce, increased very strikingly both the actual amount, and the proportion, of the Leguminous herbage. The proportion of total Leguminous herbage in the produce by mineral manures alone was 23 per cent., instead of only 5 per cent. in that without manure. The proportion of the Bird's-foot Trefoil was diminished by the mineral manures; that of the Meadow Vetchling was notably increased; and that of the Perennial Red Clover very considerably so.

The effect of *mineral* manures in developing a large proportion

of *Leguminous* herbage, and particularly of Clover, was therefore very striking. Artificial *nitrogenous* manures, on the other hand, seemed almost to extirpate such plants from the mixed herbage of the Meadow-land. These results are perfectly consistent with those observed in the manuring of Leguminous crops (beans, clover, &c.) when grown in *rotation.* Mineral manures have been found greatly to increase such crops, whenever a good plant could be once obtained and the season was not unfavourable. These crops, on the other hand—so highly nitrogenous both in their per-centage composition, and in their acreage yield—have not been found to be specially benefited by the direct use of ammoniacal salts; though nitrate of soda appears somewhat more favourable to their growth.

The general coincidence in the results obtained in regard to the action of characteristic descriptions of manure, on the agricultural plants included within each of these two great families (the Graminaceæ and the Leguminosæ), whether they be grown *separately and in alternation*, or *side by side in a mixed herbage,* is very striking. Such a coincidence, under such very varied conditions, must show, that the result is really due to the plants of the respective families requiring for their luxuriant growth a widely different relation of the mineral and nitrogenous supplies, respectively, *within the soil.* It cannot, under such circumstances, be attributed to mere local peculiarities, or to the mere accidental conditions of exhaustion induced by this or that agricultural practice. We have, then, in the facts observed in regard to the action of characteristic descriptions of manure in developing the different plants of which the *mixed herbage of a meadow* is made up, an unexpected, and very interesting confirmation, of those which have been established in regard to the development of the widely different plants which are grown *in rotation.* Such a coincidence must tend to inspire confidence in the conclusions arrived at in each of the widely different, and separately interesting, paths of inquiry.

3.—*Total Miscellaneous Herbage* (*chiefly Weeds*).

These plants were the most numerous in kind, and nearly in the greatest proportion, on the *unmanured* land. The produce without manure contained nearly 16, that grown by farm-yard manure and ammoniacal salts more than 16, and that by farm-yard manure alone 7 per cent., of Miscellaneous or Weedy herbage. In the produce without manure, about two-thirds of the amount of such herbage was Plantain or Rib-grass; and in that by the farm-yard manure and ammoniacal salts about the same proportion of the whole consisted of Rib-grass in the larger, and Sheep's Sorrel or Dock in the smaller quantity. On the other hand, the produce grown by those artificial manures which gave the largest

crops of hay, contained less than 2 per cent., and a very few species, of Miscellaneous Weedy herbage.

So much then for the results of this enquiry into the comparative development of the *different plants* of which the complex herbage of a Meadow is made up, according to the *manure* employed. The subject has been treated of with much more of system and detail than would otherwise have been necessary, inasmuch as, so far as we are aware, this is the first attempt that has been made, to trace the influence of special manures upon the individual plants of a complex herbage.

It must not be concluded, however, that the degree in which a particular description of manure develops any particular plant, when it is thus grown side by side with many others, is necessarily the same, either actually or relatively to those beside it, that it would be, were each plant grown separately, with such manure. The natural habit of a plant, its relative stage of progress at the different periods of the season, and its range of distribution both above and under ground accordingly, must indirectly affect the degree of luxuriance of the other plants associated with it. But, as it is in this *collective* way, that the various plants are grown in our permanent meadows, it is the action of different manures upon their development under these complex conditions, that is of the most interest to the farmer.

Again, the conditions of soil, situation, season, and of the original distribution and predominance of the respective plants, must, to a great extent, affect their relative development by different manures, when they are thus grown side by side. There is, moreover, evidence in the general observations made, or notes recorded, on the produce of the first two years in the experiments now in question, that there has been a *progression* from year to year, in the greater development of some plants, and in the reduction, or even exclusion, of others, the conditions of manuring remaining the same. It would appear, indeed, that great caution should be exercised in the application of artificial manures to *good feeding pastures*, lest the effect should be, to increase the growth of certain grasses of inferior quality, and to diminish or exclude those to which the high feeding value is attributable.

It is obviously very important, not only that the progressive action of the different manures should be carefully investigated for years to come, in the case of the experiments on the Rothamsted Meadow-land, but that experiments of a similar kind should be conducted by others, in different localities, and on different descriptions of soil. So far as our own part in the matter is concerned, we hope to follow up a subject which seems fraught with so much interest both in a practical and scientific point of view.

And we trust, that others will be found to lend their aid, in extending information in this important and hitherto untrodden field of inquiry.

From a review of the whole of the facts adduced in this Third Part of our Report, it would appear:—

1. That, whether the produce of hay be considerably increased by means of farm-yard manure alone, farm-yard manure and ammoniacal salts, or artificial mixtures of suitable mineral manure and ammoniacal salts, the proportion of the whole which will be *Graminaceous*, will be very much increased.

2. That the produce will be by far the *most Graminaceous* when the "*artificial mixtures*" are employed. In fact, when the increase of hay is obtained by artificial manures containing *both the necessary mineral constituents and ammoniacal salts*—and it is then greater than under any of the other conditions—both the *Leguminous* and the *Weedy* herbage are nearly excluded, and the produce is then, therefore, *almost wholly Graminaceous*.

3. That the *Graminaceous produce itself*, when grown by *farm-yard manure*, is less complex in character than that grown *without manure;* whilst that grown by the *most active artificial manures*, is *less complex still.*

4. That, up to an equal period of the season, the *Graminaceous* produce grown by the *active artificial manures*, will be in larger proportion in *flowering and seeding stem*, than that grown *without manure;* and that the produce grown by *farm-yard manure* will be in still larger proportion in that condition.

5. That the *description* of the produce grown by *farm-yard manure alone* was, upon the whole, superior to that grown *without manure.*

6. That when the crop was further increased, by the *addition of ammoniacal salts to the farm-yard manure*, the character of the produce was somewhat deteriorated, both in regard to the *description* of the *useful plants* grown, and on account of the large proportion of *Miscellaneous* or *Weedy herbage* then developed.

7. That, when in a *mixed mineral and ammoniacal manure* the ammoniacal salts were *not used in excessive amount*, the herbage, which was then almost exclusively *Graminaceous*, and comprised also but *very few species*, nevertheless, included a considerable proportion of grasses of recognised good quality. But, *when excessive amounts of ammoniacal salts were employed*, the character of the produce was deteriorated, both in regard to its *condition*, and to the *description of the grasses* that were developed.

[To be continued.]

XV.—*Hinxworth Drainage. Monthly Records of the Daily Rainfall, Discharge of Water from the Drains, Height of Barometer and Thermometer, and of the Temperature of the Soil at* 18 *and* 42 *inches, respectively, below the Surface.* By J. Bailey Denton, Agricultural Engineer.

My object in tabulating the results of the following experiments was not merely to gain tangible and irresistible proof of the draining capabilities of clay soils, but to demonstrate to what extent the close parallel system of drainage, so necessary for the drainage of clays, may be profitably departed from in soils of an open and irregular character.

The Hinxworth Estate was selected, with the permission of its owner, as embracing lands of the most opposite character. The clay lands presented a surface and subsoil, and had a local reputation, as forbidding as any clay lands I had visited in my practice as a draining engineer; and the open and mixed soils were from their position exceedingly wet and cold at that season of the year—from February to May—when a free and warm bed is most required by vegetation.

In 1849, when I first reported on the drainage of the Hinxworth Estate, I advised the owner, Mr. Clutterbuck, of Watford-house (who then contemplated some partial work), not to attempt the drainage in any other way than as a whole, because I considered that nearly every part was more or less dependent on adjacent lands, and that the work would only be satisfactory and complete when effected altogether, and by a connected scheme of operations. Mr. Clutterbuck acted upon this suggestion; and when the estate is viewed geologically in its relation to the surrounding district, and the several parts of the estate considered in relation to each other, I believe the value of the decision to deal with it as a whole will be fully appreciated.

In the winter of 1855-6, Mr. Clutterbuck determined to drain the whole estate, which consists of three farms, containing together about 800 acres.

Description of the Land.—The Estate lies at the bottom of the chalk escarpment of the London Basin, and covers a portion of the lowest bed of the chalk, the outcrop of the greensand, and a portion of the gault of the greensand formation. In several parts a superficial deposit of drifted gravel and sand overlies the older beds. The greensand separating the chalk from the gault is very thin, and, if collected in a distinct layer, would not exceed three inches in depth in its thickest part. The gault has gained a

siliceous character where it comes immediately in contact with the greensand. It has also imbibed a calcareous quality by an infiltration of the chalk through the greensand into its bed; for a wide breadth, however, the gault is denuded, and there, although the greensand is absent, a very considerable infiltration of lime has taken place, which, I presume, may be accounted for by the fact, that the chalk escarpment rises in almost cliff-like shape immediately at the margin of the gault, and any submersion of the gault has necessarily imparted to it the character of its more prominent and overwhelming neighbour.

Analyses of the Soil.—The following are by Professor Way:—

Of the Lower Chalk and Mixed Drift.

Moisture and organic matter	3·27
Sands and clays	24·37
Silica soluble in acids	1·23
Oxide of iron	1·14
Phosphate of lime	0·92
Sulphate of lime	0·76
Carbonate of lime	68·31
	100·0

Of the Gault (at 24 inches deep).

Moisture and organic matter	5·01
Sands	0·66
Clay	63·26
Carbonate of lime	31·07
	100·0

Of the Gault (at 42 inches deep).

Moisture and organic matter	4·28
Sands	0·34
Clay	62·97
Carbonate of lime	32·41
	100·0

Mode of Draining.—The lands of mixed open character, no less than those of the gault clay, had suffered previously from excessive wetness, although they had been drained from time to time with bushes laid, without distinction of soil, at close intervals, and from 15 to 18 inches deep. Under my directions a connected system of works was adopted to secure an effective discharge of the water drained from the higher through the lower

ground, though a distinctly different subordinate treatment was applied to the two descriptions of lands.

The mixed open soils were drained by occasional and wide parallel drains (from 4 to 8 feet deep), sufficient to discharge the rainfall and relieve the pressure of subterranean water passing through the soil from the higher grounds to their natural outfalls, at a cost varying from 1*l.* 10*s.* to 3*l.* 10*s.* per acre. The drains in this description of soil were reduced to a minimum in number, on the principle that any excess of work beyond that sufficient to remove excess of wetness would be a waste of outlay; whereas in the gault clay soils,—which were drained uniformly by a parallel arrangement of drains 25 and 27 feet apart, 4 feet deep, at a cost varying from 5*l.* 10*s.* to 6*l.* 10*s.* per acre,—the reverse principle governed the operations, the number of drains being increased to a maximum consistent with economy: the object being two-fold—not only to remove excess of wetness, but to promote an uniform aëration of the mass of clay above the level of the drains, so as to counteract as much as possible its absorbent and retentive nature.

The total net cost of draining the 800 acres was 3,357*l.* 10*s.*; giving an average cost per acre of 4*l.* 4*s.*; and a map was furnished showing the position of every drain in order that additional drains might be put in without derangement of the system should any addition be found necessary.

Description of the tabular Records.—I. Rainfall.—The daily quantity of rain which fell during the period over which the experiments extend, is shown in columns 1 and 2.

II. Barometric Observations.—The height of the barometer at the time of recording the rainfall is indicated in column 3.

III. Discharge of Water from the Drains.—The discharge from the different outlets is exhibited in columns 7, 9, 11, and 16. It will be observed that the discharge from the mixed open soils was much more regular than from the clays. The quantity of water discharged by the comparatively few drains of the freest description of soil, during the period of the experiments, was 160,920 gallons per acre, out of 227,240 gallons, which the rain-gauge showed fell upon every acre drained, while the quantity discharged from the numerous drains of the clays was only 59,936 gallons per acre.

The steady discharge of more than 1000 gallons per acre per diem from the mixed open soils during the winter—when evaporation is so much less than during the summer—is a fact of considerable importance when considered in relation to the wide extent of similar land requiring drainage. It will be observed, too, that after the Autumn rains had completely replenished the

HINXWORTH DRAINAGE.—MONTHLY RECORDS FROM 1st OCTOBER, 1856,

	1	2	3	4	5	6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Fields Nos. 18, 19, 20.—46 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Nos. 19 and 20 only, containing 25 acres, Drained at this time.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.	
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side. Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side. Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).
1	..	..	No record of the changes of the barometer made before 21st October, 1856.	5 11	5 4	$1\frac{1}{4}$	75	Nil.	Nil.
2	..	..		5 10	5 3	$1\frac{3}{4}$	105	..	..
3	..	..		5 9	5 2	$1\frac{3}{8}$	80	..	..
4	·105	2,375		5 8	5 0	$1\frac{1}{2}$	90	..	..
5	·200	4,525		5 6	4 10	2	120	..	..
6	·060	1,355		5 $3\frac{1}{2}$	4 8	$1\frac{3}{8}$	80	..	..
7	·080	1,810		5 2	4 5	2	120	..	..
8	·185	4,185		5 0	4 $3\frac{1}{2}$	$2\frac{5}{8}$	160	..	..
9	·040	905		4 10	4 2	4	235	..	..
10	·060	1,355		4 9	4 1	$6\frac{1}{4}$	360	..	..
11	·195	4,410		4 8	3 11	9	530	..	..
12	·415	9,390		4 6	3 7	$27\frac{1}{2}$	1,585	1–4th	20
13	·005	115		4 5	3 8	24	1,410	1–4	20
14	..	..		4 4	3 9	$19\frac{1}{2}$	1,115	1–8	10
15	·115	2,600		4 $4\frac{1}{2}$	3 $9\frac{1}{2}$	15	880	1–8	10
16	·070	1,585		4 5	3 10	$10\frac{1}{2}$	605	1–8	10
17	·100	2,260		4 $5\frac{1}{2}$	4 0	10	580	1–8	10
18	·005	115		4 6	4 2	9	530	1–8	10
19	..	..		4 $6\frac{1}{2}$	4 2	$8\frac{1}{2}$	495	1–8	10
20	..	..		4 7	4 2	8	470	1–8	10
21	..	..	30·12	4 7	4 2	8	470	1–9	9
22	..	..	30·28	4 $7\frac{1}{2}$	4 $2\frac{1}{2}$	7	400	1–9	9
23	..	..	30·26	4 8	4 3	$6\frac{1}{2}$	375	1–10	8
24	..	..	30·38	4 $8\frac{1}{2}$	4 3	6	350	1–12	7
25	..	..	30·40	4 9	4 3	6	350	1–16	5
26	..	..	30·39	4 9	4 3	5	285	1–16	5
27	..	..	30·36	4 $9\frac{1}{2}$	4 3	$4\frac{1}{4}$	250	1–16	5
28	·002	45	30·28	4 10	4 3	4	235	1–16	5
29	·003	70	30·20	4 10	4 3	$3\frac{3}{4}$	220	1–16	5
30	..	..	30·10	4 10	4 3	3	175	1–16	5
31	·005	115	30·05	4 10	4 3	3	175	1–16	5
Total	1·645	37,215		Total quantity of Water per Acre discharged			12,910	..	178
				Remainder unaccounted for ..			24,305	..	37,037
						Total Rainfall ..	37,215	..	37,215

TO 31ST MAY, 1857.—RECORD FOR OCTOBER, 1856.

10	11	12	13	14	15	16	17	18	19	20	21	22
PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33.—Nos. 31 and 32 only drained. 29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, A.M.					
							Undrained Land.			Drained Land.		
Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes dug 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27.		Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
		Drained Land.										
Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Un-drained Land No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).						
$1\frac{1}{4}$	75	Nil	Nil	No observations made this month.	Nil	Nil	No observations made this Month on the Temperature of the Soil.					
$1\frac{1}{4}$	75	Nil	Nil		..	..						
$1\frac{1}{4}$	75	4 $9\frac{1}{2}$	4 9		..	..						
$1\frac{1}{4}$	75	4 $9\frac{1}{2}$	4 9		..	..						
$1\frac{1}{4}$	75	4 9	4 $8\frac{1}{2}$		..	..						
$1\frac{3}{8}$	80	4 $8\frac{1}{2}$	4 8		..	..						
$1\frac{3}{4}$	105	4 9	4 $8\frac{1}{2}$		..	..						
$19\frac{1}{3}$	1,160	4 10	4 $9\frac{3}{4}$		..	..						
$6\frac{3}{4}$	405	4 $10\frac{1}{2}$	4 10		..	..						
$6\frac{3}{4}$	405	4 11	4 $10\frac{1}{2}$		..	..						
$6\frac{1}{2}$	390	4 $11\frac{1}{2}$	4 11		..	..						
30	1,800	4 $10\frac{1}{2}$	4 10		..	..						
$8\frac{1}{3}$	490	4 11	4 11		..	..						
$3\frac{1}{2}$	210	Nil	Nil		..	..						
4	235	..	..		..	..						
6	360	..	..		..	..						
6	360	..	..		..	..						
7	420	..	..		..	..						
6	350	..	..		..	..						
4	235	..	..		..	..						
$3\frac{1}{2}$	210	..	..		..	..						
$3\frac{1}{4}$	195	..	..		..	..						
3	180	..	..		..	..						
3	180	..	..		..	..						
$2\frac{3}{4}$	165	..	..		..	..						
$2\frac{1}{2}$	150	..	..		..	..						
$2\frac{3}{8}$	140	..	..		..	..						
$2\frac{1}{8}$	130	..	..		..	..						
2	120	..	..		..	..						
2	120	..	..		..	..						
$1\frac{3}{4}$	105	..	..		..	..						
..	9,075	..	..	..	..	..						
..	28,150	..	..	..	..	37,215						
..	37,215	..	..	..	..	37,215						

HINXWORTH DRAINAGE.—RECORD

	1	2	3	4		5		6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Fields Nos. 18, 19, 20.—46 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before draining. Nos. 19 and 20 only drained up to Nov. 10, when the draining of Nov. 18 was commenced. It was finished Nov. 29.						PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Holes 6 feet deep.				Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 in. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, five inches. Commenced running October 12.	
Day of the Month.	Per diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock, A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side. Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.		Lower Side. Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.		Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem)
1	·312	7,058	30·28	4	10	4	3	9½	555	1–8	10
2	·003	68	30·29	4	10	4	3	5	285	1–9	9
3	..	..	30·19	4	10	4	3	3	175	1–10	8
4	..	..	30·18	4	10	4	3	3	175	1–10	8
5	..	..	30·30	4	10	4	3	3	175	1–10	8
6	..	..	30·40	4	10	4	3	3	175	1–10	8
7	·005	113	30·50	4	10	4	3	3	175	1–10	8
8	..	..	30·37	4	10	4	3	3	175	1–10	8
9	·355	8,030	30·06	4	10	4	3	12	700	2–3	50
10	·005	113	29·50	4	10	4	3	5⅝	Field No. 18 being drained and added to this outlet, the daily measurements were only approximately taken.	3–8	30
11	..	..	29·30	4	10	4	3	5		3–8	30
12	·215	4,864	29·60	4	9	4	3	6⅞		1–2	40
13	·002	45	29·70	4	9	4	3	7		1–2	40
14	·003	68	29·79	4	9	4	3	7½		3–8	30
15	..	..	29·80	4	9	4	3	7½		3–8	30
16	..	..	30·10	4	9	4	3	8		1–4	20
17	..	..	30·10	4	9	4	3	9		1–4	20
18	·040	905	30·00	4	9	4	3	9		1–4	20
19	·072	1,628	30·04	4	9	4	3	12½		1–3	25
20	·053	1,199	29·09	4	9	4	3	15		1–2	40
21	·005	113	30·15	4	9	4	3	15¾		1–2	40
22	..	..	30·17	4	9	4	3	16		1–3	25
23	..	..	29·70	4	9	4	3	16		1–3	30
24	..	..	29·60	4	9	4	3	17		1–3	25
25	..	..	29·50	4	9	4	3	17		1–3	30
26	·015	339	29·60	4	9	4	2½	17¾		1–3	25
27	·540	12,216	29·58	4	8	4	2	33		11¼	900
28	·005	113	29·68	4	7	4	0	34½		3	240
29	..	..	29·68	4	7½	4	1	32		2	160
30	..	..	29·69	4	7½	4	1	30		2	160
Total	1·630 1·645	36,872 37,215		Total quantity of Water per Acre discharged					27,000	..	2,07
				Remainder unaccounted for ..					9,872	..	34,79
	3·275	74,087		Total Rainfall					36,872	..	36,87

OF THE MONTH OF NOVEMBER, 1856.

10	11	12	13	14	15	16	17	18	19	20	21	22
PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay with Lime infiltrated, Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, A.M.					
							Undrained Land.			Drained Land.		
Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.		Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
		Drained Land.										
Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre In Gallons (per diem).						
2¾	165	Nil	Nil	No observations made prior to November 27.	Nil	Nil	No observations made this Month on the Temperature of the Soil.					
1¾	105	..	..		..	..						
1½	90	..	..		..	..						
1¼	75	..	..		..	..						
1	60	..	..		..	..						
1	60	..	..		..	..						
1	60	..	..		..	..						
1½	90	..	..		..	..						
6	360	..	..		..	..						
5½	330	..	..		..	..						
5½	330	..	..		..	..						
5½	330	..	..		..	..						
5	300	..	..		..	..						
4¾	285	..	..		..	..						
4¾	285	..	..		..	..						
3½	210	..	..		..	..						
2½	150	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
2¼	135	..	..		..	..						
3¼	195	..	..		..	..						
12¼	735	4 11	4 11	3 0	2¼	135						
5	300	4 11½	4 11½	2 10	1¼	65						
4	240	..	..	2 10	1¼	65						
3	180	..	..	2 9½	1¼	65						
..	6,015	..	..	..	..	330						
..	30,857	..	..	..	..	36,542						
..	36,872	..	..	..	..	36,872						

HINXWORTH DRAINAGE.—RECORD

Day of the Month.	1	2	3	4	5	6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Fields Nos. 18, 19, 20.—46 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining.				PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field, remainder Gault and Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep.		Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of Water from Outlet No. 9, which discharges the Drain-water from No. 22. Size of Pipe, five inches. Commenced running October 12.	
	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the outlets, 8 o'clock, A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side. Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.	Lower Side. Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).
1	..	..	29·80	4 8	4 1	28½	895	1½	120
2	..	..	29·80	4 8	4 1	25	780	1¾	140
3	..	..	29·69	4 8	4 1½	22½	695	1⅞	150
4	..	..	29·90	4 8	4 1½	20	620	1⅞	150
5	·073	1,651	29·59	4 8	4 1½	25½	795	1⅞	150
6	·027	610	29·40	4 8	4 1½	24½	755	1⅞	150
7	·050	1·131	29·49	4 8	4 1½	25½	795	2	160
8	..	..	29·49	4 8	4 1½	24½	755	2¼	180
9	·080	1,810	29·40	4 8	4 1½	27	830	3	240
10	·060	1·357	29·30	4 8	4 1½	26¼	820	3	240
11	·075	1,696	29·40	4 8	4 1½	24	745	6	480
12	·085	1,923	29·27	4 8	4 1½	22½	695	8	640
13	·452	10,225	28·89	3 8	2 11	77½	2,420	19	1,520
14	·023	520	29·40	3 10	3 0	55	1,715	10	800
15	..	..	30·20	3 10	3 2	47½	1,485	6	480
16	..	..	30·49	4 0	3 7	47½	1,485	6	480
17	..	..	30·37	4 1½	4 0	46¾	1,455	6	480
18	..	..	29·80	4 0	4 0½	40	1,245	5⅜	450
19	·100	2,262	30·30	4 2	4 2	34¼	1,085	6⅞	550
20	·005	113	30·38	4 2	4 2	37	1,145	6½	520
21	..	..	30·39	4 2	4 2	35	1,095	5¾	460
22	..	..	30·00	4 2½	4 2½	33	1,030	5¼	420
23	..	..	29·90	4 4	4 4	33	1,030	4⅞	395
24	·045	1,018	29·40	4 3	4 3	35	1,095	4¾	380
25	..	..	28·80	4 5	4 5	30	935	4½	360
26	..	..	28·70	4 6	4 6	26¼	820	4¼	340
27	..	..	29·19	4 6	4 6	21	660	3½	280
28	..	..	29·46	4 6½	4 6½	19	595	3	240
29	..	..	29·80	4 7	4 7	15¼	475	2¼	180
30	·150	3,393	30·10	4 6	4 6	19	595	5	400
31	·010	226	30·14	4 6½	4 2	18¾	590	4½	360
Total	1·235	27,935		Total quantity of Water per Acre discharged.			30,135	..	11,895
				Rainfall			27,935	Difference unaccounted for.	16,040
				Excess discharged from the Soil			2,630	Rainfall	27,935

OF THE MONTH OF DECEMBER, 1856.

10	11	12	13	14	15	16	17	18	19	20	21	22
PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, A.M.					
Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. Test Holes dug 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.		Undrained Land.			Drained Land.		
		Drained Land.										
Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 33.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
$4\frac{7}{8}$	295	Nil.	Nil.	2 9	$1\frac{1}{4}$	65	No observations made this Month on the Temperature of the Soil.					
$3\frac{1}{2}$	210	..	..	2 7	$1\frac{1}{8}$	55						
$2\frac{1}{4}$	135	..	..	2 6	$\frac{5}{8}$	30						
2	120	..	..	2 6	$\frac{5}{8}$	30						
$3\frac{3}{8}$	200	..	..	2 5	$\frac{3}{4}$	40						
$3\frac{3}{8}$	200	..	..	2 $5\frac{1}{2}$	$\frac{3}{4}$	40						
4	235	..	..	2 5	$\frac{7}{8}$	45						
$4\frac{3}{4}$	285	..	..	2 $4\frac{1}{2}$	$\frac{7}{8}$	45						
5	300	..	..	2 4	$\frac{7}{8}$	45						
$5\frac{1}{4}$	315	4 $11\frac{1}{2}$	4 11	2 4	1	50						
15	900	4 11	4 11	2 4	2	100						
$22\frac{1}{2}$	1,350	4 $10\frac{1}{2}$	4 10	2 $3\frac{1}{2}$	$3\frac{1}{8}$	160						
$47\frac{1}{2}$	2,850	4 9	4 9	6	$19\frac{1}{2}$	975						
25	1,500	4 9	4 8	7	15	750						
$15\frac{3}{4}$	945	4 9	4 8	7	$13\frac{1}{2}$	675						
$10\frac{1}{2}$	630	4 9	4 8	10	$7\frac{1}{2}$	375						
9	540	4 9	4 8	$10\frac{1}{2}$	$8\frac{1}{4}$	415						
$6\frac{3}{4}$	405	4 9	4 8	11	$3\frac{3}{4}$	185						
8	480	4 9	4 8	1 0	$4\frac{1}{2}$	225						
$7\frac{1}{2}$	450	4 9	4 8	1 1	$3\frac{1}{8}$	160						
$7\frac{1}{2}$	450	4 9	4 8	1 1	3	150						
$7\frac{1}{2}$	450	4 9	4 9	1 2	$2\frac{1}{2}$	125						
$7\frac{1}{2}$	450	4 8	4 9	1 4	$2\frac{1}{4}$	110						
7	420	4 8	4 9	1 4	2	100						
6	360	4 8	4 10	1 4	2	100						
$5\frac{1}{4}$	315	4 8	4 10	1 4	$1\frac{7}{8}$	95						
4	235	4 9	4 10	1 4	$1\frac{1}{4}$	65						
3	180	4 9	4 10	1 4	1	50						
$2\frac{5}{8}$	160	4 9	4 10	1 4	$\frac{3}{4}$	40						
$6\frac{1}{2}$	390	4 7	4 9	1 3	6	300						
$5\frac{5}{8}$	340	4 $6\frac{1}{2}$	4 9	1 3	$4\frac{1}{2}$	225						
..	16,095	..	..	..	..	5,825						
..	12,000	..	..	..	..	22,110						
..	27,935	..	..	..	..	27,935						

HINXWORTH DRAINAGE.—RECORD

Day of the Month.	1 — Rainfall. Per Diem. Inches dec.	2 — Rainfall. Per Acre. (Per Diem.) In Gallons.	3 — Barometer. Height at the time of recording the Discharge from the Outlets, 8 o'clock A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4 — Occasional Drainage. Fields Nos. 18, 19, 20.—46 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep. Higher Side. Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.		5 — Lower Side. Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.		6 — Quantity of Water from Outlet No. 7, which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1. Per Minute. In Gallons.	7 — Per Acre. In Gallons (per diem.)	8 — Part Occasional and part Wide Parallel Drainage. Field No. 22. 18 Acres. Soil, same as last in part of field, remainder Gault and Gravel mixed. Quantity of Water from Outlet No. 9, which discharges the Drain Water from No. 22. Size of Pipe, 5 inches. Commenced running October 12. Per Minute. In Gallons.	9 — Per Acre. In Gallons (per diem)
1	·005	113	30·30	4	6	4	2	16	500	2½	200
2	·020	452	29·48	4	6	4	2	21	660	3¾	300
3	·042	950	29·20	4	6	4	2	24	750	5	400
4	·151	3,416	29·07	4	6	4	1	29	900	14½	1,150
5	·162	3,665	29·64	4	6	4	1	31	980	15¾	1,260
6	..	..	30·09	4	5½	4	0½	30	930	11¼	900
7	..	..	30·20	4	5	4	0	31½	995	7¼	580
8	..	..	30·24	4	5	4	1	28½	895	5¼	420
9	·035	792	30·13	4	4½	4	0	29	910	5	400
10	·542	12,261	29·46	3	5	2	8	62	1,945	45	3,600
11	·300	6,787	28·80	3	0	2	2	57½	1,800	40	3,200
12	·162	3·665	29·19	2	1	1	11	53¾	1,680	30¾	2,460
13	..	..	29·39	2	7	2	5	55	1,720	22½	1,800
14	..	..	29·80	3	2	2	11	55	1,720	12¾	1,020
15	..	..	29·90	3	6	3	3	50	1,560	9	720
16	·135	3,054	29·90	3	10	3	8	52½	1,640	9¾	780
17	..	..	30·20	4	1½	4	0	51½	1,605	9	720
18	·005	113	30·19	4	2	4	0	48	1,500	9	720
19	·005	113	30·17	4	3½	4	1	45	1,395	9	720
20	..	..	29·69	4	3	3	11½	43¾	1,350	9¾	780
21	·065	1,470	29·40	4	2	3	11	50	1,560	16½	1,320
22	·120	2,714	29·69	4	1	3	10	52½	1,640	17¼	1,380
23	·062	1,402	29·28	4	0½	3	9	53¾	1,680	18	1,440
24	·035	792	29·04	4	1	3	10	52½	1,640	16½	1,320
25	·145	3,280	29·27	4	0	3	8	61	1,900	37½	3,000
26	·130	2,940	29·59	3	7	3	7	62½	1,960	45	3,600
27	·112	2,534	29·70	3	7	3	3	57½	1,800	21	1,680
28	..	..	29·79	3	9	3	5	56¼	1,770	11	880
29	..	..	29·70	3	10½	3	6½	51¼	1,595	10½	840
30	..	..	29·73	4	0	3	9	45	1,395	9	720
31	·100	2,262	29·58	4	0½	3	8	47½	1,480	9¾	780
Total	2·333	52,775		Total quantity of Water per Acre discharged					43,855	..	39,090
				Remainder unaccounted for ..					8,920	..	13,685
				Total Rainfall					52,775	..	52,775

OF THE MONTH OF JANUARY, 1857.

10	11	12		13		14		15	16	17	18	19	20	21	22
PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33.—Nos. 31 and 32 only drained. 29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.								TEMPERATURE. At half-past Seven A.M.					
										Undrained Land.			Drained Land.		
Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.						Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe, 7 inches. Commenced running November 27.		Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above Surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
		Drained Land.													
Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.		Lower Side. 25 ft. apart and 4 ft. deep. No. 31.		Undrained Land. No. 33.		Per Minute. In Gallons.	Per Acre. In Gallons (per diem).						
4¼	250	4	6	4	6	1	2	2	100	No observations made prior to the 6th of this month.					
5	300	4	6	4	6	1	2	$3\frac{3}{9}$	170						
9¼	550	4	5	4	5	1	2	8	400						
33	1,900	4	4	4	4	1	2	18	900						
40½	2,430	4	3	4	3	1	1½	21	1,050						
19½	1,170	4	3	4	3½	1	3	12	600	31	..	No observations recorded.	31	..	No observations recorded.
18½	1,130	4	3	4	3½	1	2½	4½	225	32	34		33	34	
9	540	4	3	4	3	1	3	3	150	34	34		36	35	
8	480	4	3	4	3½	1	3	2⅝	125	37	35		38	36	
101½	6,060	4	0	4	0	0	5	103	5,150	44	36		44	37	
75	4,500	4	0	4	0	0	5	80	4,000	37	37		43	38	
46½	2,790	3	11	3	11	0	4	40	1,990	37	37		32	38	
35	2,085	4	0	4	0	0	5	25	1,250	32	37		31	37	
18	1,080	4	0	4	0	0	6	12	600	28	36		29	37	
11¼	660	4	0	4	0	0	9	7½	375	32	35		33	35	
14¼	840	4	1	4	1	1	0	8¼	410	27	34		31	35	
13½	810	4	1½	4	2	1	0	7½	375	29	31		33	34	
14¼	850	4	1	4	2	1	0	7½	375	43	30		44	35	
15¾	945	4	1	4	2	1	0	7½	375	41	36		42	36	
16¾	1,005	4	0	4	0	1	0½	8¼	410	38	32		39	37	
24	1,440	3	10½	3	10	1	0	13½	680	32	31		32	36	
24¾	1,485	3	10	3	10	0	10	19¾	985	29	32		30	37	
24	1,440	3	9	3	9	0	9	19¾	985	32	31		34	35	
22¼	1,310	3	9½	3	9	0	10	18	900	35	33		36	37	
56¼	3,400	3	8	3	9	0	10	54	2,700	34	32		35	36	
57½	3,450	3	5	3	9	0	10	55	2,750	31	32		32	34	
41½	2,460	3	2½	3	2½	1	0	35	1,750	28	33		29	35	
20¼	1,200	3	3	3	3	1	0	15	750	17	33		18	35	
16¾	995	3	3½	3	3½	1	0	11¼	560	16	32		17	34	
13¼	795	3	4	3	4	1	0	6¾	340	21	31		22	33	
15	900	3	3	3	3	0	11	7½	375	30	33		31	34	
..	49,250	..		..		..		..	31,805	..	..		..	..	
..	3,525	..		..		..		..	20,970	..	..		..	..	
..	52,775	..		..		..		..	52,775	..	..		..	..	

HINXWORTH DRAINAGE.—RECO

	1	2	3	4		5		6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Fields Nos. 18, 19, 20.—46 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Green Sand is found mixed with Gault Clay. Also Coprolites. Very wet before Draining.						PART OCCASIO AND PART WIDE PARALL DRAINAGE. Field No. 22. Acres.—Soil, sam last in part of fi remainder Gault Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 6 feet deep.				Quantity of Water from Outlet No. 7. which discharges the Drain Water from 18, 19, and 20. Size of Pipe, 8 inches. Commenced running October 1.		Quantity of W from Outlet No. which discharges Drain Water fi No. 22. Size of P five inches. Co menced running tober 12.	
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the Outlets, 8 o'clock A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher side. Distance from Drain to Drain 59 yds. Depth of Drains 4 ft. 11 in.		Lower Side. Distance from Drain to Drain 57 yds. Depth of Drains 4 ft. 4 in.		Per Minute. In Gallons.	Per Acre. In Gallons (per diem.)	Per Minute. In Gallons.	Per Ac In Gall (per die
1	..	..	29·79	4	1	3	8	40	1,245	7	5
2	..	..	29·59	4	2	3	8½	33¾	1,055	6¾	5
3	..	..	29·60	4	3½	3	9	32½	1,015	6	4
4	..	..	30·07	4	5	3	10	32½	1,015	4½	3
5	..	..	30·08	4	6	3	11½	35	1,095	6	4
6	·100	2,262	29·77	4	5	3	11	38¾	1,210	12¾	1,0
7	·025	565½	29·67	4	4	3	10	50	1,560	16½	1,3
8	..	..	29·59	4	4	4	0	45	1,395	12	9
9	..	..	29·58	4	4	4	1	41½	1,285	9	7
10	·022	497½	29·57	4	5	4	2	40	1,245	9	7
11	·020	452½	29·69	4	6	4	3	37½	1,175	8½	68
12	·010	226¼	30·20	4	7	4	4	36½	1,150	6¾	54
13	..	..	30·20	4	7½	4	4	37½	1,175	6¾	54
14	..	..	30·20	4	8	4	4	35	1,090	6¾	54
15	..	..	30·16	4	8	4	4	32	1,000	6	48
16	..	..	30·05	4	9	4	4	30	935	6	48
17	..	..	30·00	4	9½	4	4	27½	860	4½	36
18	..	..	29·90	4	10	4	4	27½	860	4½	36
19	..	..	30·09	4	10½	4	4	26¼	820	4½	36
20	·015	339¼	30·14	4	10½	4	4	25	780	4½	36
21	..	..	30·18	4	11	4	4	23¾	745	4	32
22	..	..	30·19	4	11	4	4	22	690	4	32
23	..	..	30·19	4	11	4	4	21	660	4	32
24	..	..	30·20	4	11	4	4	21	660	3¾	30
25	..	..	30·10	4	11	4	4	21	660	3¾	30
26	..	..	30·38	4	11	4	4	21	660	3¾	30
27	..	..	30·37	4	11	4	4	21	660	3¾	30
28	..	..	30·39	4	11	4	4	21	660	3¾	30
Total	·192	4,343		Total quantity of water per Acre discharged					27,360	..	14,32
				Rainfall					4,343	..	4,34
				Excess discharged from soil ..					23,017	..	9,97

[FOR] THE MONTH OF FEBRUARY, 1857.

10	11	12	13	14	15	16	17	18	19	20	21	22
[P]ARALLEL DRAINAGE. [Fie]lds 13 and part 14.—24 [A]cres. Soil, Gault Clay [w]ith Lime infiltrated. [P]atches and veins of Sand [fo]und giving vent to [u]nder water which has [ru]n through the Summer [o]f 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable, Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, A.M.					
[Qu]antity of Water from [O]utlet No. 13, which dis[c]harges the Drain Water [fr]om Nos. 13 and part 14. [S]ize of Pipe, 5 inches. [H]as run throughout the [y]ear.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.		Undrained Land.			Drained Land.		
		Drained Land.										
[Pe]r Minute. [In] Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground, No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above Surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
12	720	..	..	1 0	7	350	27	32	No observations recorded prior to the 21st of this month.	28	33	39
8¼	495	3 1½	3 3½	1 0	6	300	25	32		26	33	39
6¾	405	3 2	3 4	1 1	5¼	260	21	32		22	33	38
5¼	315	3 3	3 5	1 2	3¾	185	24	31		25	32	38
6¾	405	3 4	3 6	1 2	5¼	265	26	32		27	33	38
9½	570	3 2	3 4	1 2	9	450	27	32		28	33	38
31½	1,890	2 10	3 0	1 0	25	1,250	40	31		41	33	38
18	1,080	2 10	2 11	1 0	17	850	38	32		39	34	38
10½	630	2 10	2 11	1 0	12	600	44	32		45	33	38
9¾	585	2 10	2 11	1 1	9	450	35	33		36	34	37
10½	630	3 0	2 11	1 2	7½	375	35	34		36	35	37
9¾	585	3 1	3 0	1 2	7½	375	31	35		32	36	38
9¾	585	3 2	3 1	1 2	7½	375	32	35		33	36	38
9	540	3 3	3 2	1 2½	7½	375	40	34		40	35	38
8¾	525	3 3	3 2	1 3	6½	325	32	34		33	35	38
8¾	525	3 4	3 3	1 3	6	300	25	35		25	36	39
7½	450	3 4½	3 4	1 3	5¼	260	42	35		41	35	40
6¼	375	3 5	3 5	1 3½	4½	225	40	35		40	36	40
6¼	375	3 5½	3 6	1 3½	3¾	185	42	35		41	37	40
5	300	3 6	3 6½	1 3½	3¾	185	40	36		39	38	40
5	300	3 6½	3 7	1 4	3	150	42	37		40	39	41
4	240	3 7	3 8	1 5	3	150	42	37	39	42	39	41
3¾	225	3 7	3 8	1 5½	3	150	34	37	39	34	39	41
3	180	3 7½	3 8	1 6	3	150	40	37	39	40	39	41
3	180	3 8	3 8½	1 6	3	150	30	37	39	31	39	41
3	180	3 8	3 9½	1 6	3	150	23	37	39	23	39	41
3	180	3 8	3 10½	1 6	2¼	110	36	37	39	36	39	41
3	180	3 8½	3 11½	1 6	2¼	110	43	37	39	43	39	41
..	13,650	..	..	..	..	9,060	..	..	..	..	..	..
..	4,343	..	..	..	..	4,343	..	..	..	..	..	..
..	9,307	..	..	..	..	4,717	..	..	..	..	..	..

HINXWORTH DRAINAGE.—RECORD

	1	2	3	4		5		6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Field No. 40.—16 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining. (The fields are changed because Coprolites were raised in No. 19 this month, and interfered with the discharge.)						PART OCCASIONAL AND PART WIDE PARALLEL DRAINAGE. 18 Acres.—Soil, same as last in part of field remainder Gault and Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep.				Quantity of Water from Outlet No. 8, which discharges the Drain-water from Field No. 40.		Quantity of Water from Outlet No. 9 which discharges the Drain-water from No. 22. Size of Pipe five inches. Commenced running October 12.	
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the outlets, 8 o'clock, A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side. Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in.		Lower Side. Distance from Drain to Drain 33 yds. Depth of Drains 6 ft.		Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per Acre. In Gallons (per diem)
1	..	..	30·49	4	2	5	6½	4½	405	3¾	300
2	..	..	30·48	4	2½	5	6½	4½	405	3¾	300
3	..	..	30·39	4	2½	5	6½	4½	405	3⅛	250
4	..	..	30·08	4	3	5	6½	4½	405	3	240
5	..	..	30·28	4	3½	5	6½	4½	405	2⅝	210
6	..	..	30·00	4	4	5	6½	5¼	472½	3¾	300
7	..	..	29·85	4	4½	5	6½	5¼	472½	3¾	300
8	..	..	29·49	4	5	5	6½	5	450	3¾	300
9	·030	675	29·66	4	5	5	7	4½	405	2⅝	210
10	·050	1,130	29·90	4	6	5	7	4½	405	3	240
11	·065	1,470	29·80	4	7	5	7	5¼	472½	3½	280
12	..	..	29·89	4	8	5	7	5¼	472½	4½	360
13	..	..	29·79	4	9	5	7	5¼	472½	4½	360
14	·060	1,360	29·00	4	9½	5	7	5¼	472½	5¼	420
15	·033	746	29·25	4	9½	5	7	5	450	4½	360
16	..	..	29·79	4	10	5	7	3	270	3¾	300
17	..	..	29·80	4	11	5	7	2¼	200	3¾	300
18	..	..	29·69	5	0	5	7	1½	135	4¼	180
19	·040	905	29·79	5	1	5	7	¾	67½	3¾	300
20	·100	2,262	29·80	5	1½	5	7	¾	67½	2¼	180
21	..	..	30·00	5	2	5	7	¾	67½	2¼	180
22	..	..	29·80	5	2	5	7	¾	67½	2¼	180
23	·122	2,760	29·60	5	2½	5	7	1½	135	2¼	180
24	·010	227	29·59	5	3	5	7	1½	135	2¼	180
25	·015	339	29·40	5	3	5	7	1½	135	2¼	180
26	·005	113	29·59	5	3	5	7	¾	67½	2¼	180
27	..	..	29·88	5	3	5	7	¾	67½	2¼	180
28	..	..	30·00	5	3½	5	7	¾	70	2½	200
29	·030	678	29·78	5	3	5	6	1	90	2½	200
30	·180	4,072	29·28	5	3	5	6	1½	135	3	240
31	·080	1,810	29·18	5	3	5	6	1½	135	3	240
Total	·820	18,547	..	Total quantity of water per acre discharged					8,415	..	7,830
				Remainder unaccounted for ..					10,132	..	10,717
				Total Rainfall ..					18,547	..	18,547

OF THE MONTH OF MARCH, 1857.

10–11. PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.

Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe, 5 inches. Has run throughout the year.

12–16. CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.

12–14: Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.

15–16: Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.

17–22. TEMPERATURE. At half-past Seven, A.M.

10	11	12	13	14	15	16	17	18	19	20	21	22
		Drained Land.					Undrained Land.			Drained Land.		
Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
3	180	3 9	3 11	1 6	$2\frac{1}{4}$	110	35	37	39	36	40	41
3	180	3 9	3 11	1 6	$2\frac{1}{4}$	110	43	37	39	44	40	41
3	180	3 9	4 0	1 6	$2\frac{1}{4}$	110	43	38	40	44	41	43
3	180	3 $9\frac{1}{2}$	4 0	1 6	$2\frac{1}{4}$	110	44	38	40	43	41	42
3	180	3 $9\frac{1}{2}$	4 0	1 6	$2\frac{1}{4}$	110	24	38	40	25	41	42
$4\frac{1}{2}$	270	3 $9\frac{1}{2}$	4 0	1 6	3	150	45	38	40	45	41	42
$4\frac{1}{2}$	270	3 $9\frac{1}{2}$	4 0	1 6	3	150	34	38	40	34	41	42
$4\frac{1}{2}$	270	3 10	4 0	1 6	3	150	47	38	40	46	41	42
$4\frac{1}{2}$	270	3 10	4 0	1 6	3	150	38	37	40	39	40	42
$5\frac{1}{4}$	315	3 10	4 0	1 6	$3\frac{3}{4}$	185	27	36	39	28	39	41
6	360	3 10	4 0	1 6	$4\frac{1}{2}$	225	31	36	39	32	38	41
6	360	3 10	4 0	1 6	$4\frac{1}{2}$	225	32	36	39	32	38	41
$5\frac{1}{4}$	315	3 10	4 0	1 6	$3\frac{3}{4}$	185	31	36	39	31	38	41
$5\frac{1}{4}$	315	3 10	4 0	1 6	$3\frac{3}{4}$	185	42	36	40	42	39	41
4	240	3 10	4 0	1 6	3	150	43	37	40	44	40	41
3	180	3 10	4 0	1 6	$2\frac{1}{4}$	112	37	38	40	37	40	41
$2\frac{1}{4}$	135	3 10	4 0	1 6	$1\frac{1}{2}$	75	42	38	40	42	40	41
3	180	3 10	4 0	1 $6\frac{1}{2}$	$1\frac{1}{2}$	75	46	38	40	46	40	41
$1\frac{1}{2}$	90	3 $11\frac{1}{2}$	4 0	1 7	$\frac{3}{4}$	37	49	40	41	48	42	42
$1\frac{1}{2}$	90	3 $11\frac{1}{2}$	4 0	1 $7\frac{1}{2}$	$\frac{3}{4}$	38	47	41	41	47	43	42
$1\frac{1}{2}$	90	4 0	4 0	1 $7\frac{1}{2}$	$\frac{3}{4}$	38	36	41	41	37	43	42
$1\frac{1}{2}$	90	4 0	4 0	1 $7\frac{1}{2}$	$\frac{3}{4}$	38	34	40	41	35	42	42
$1\frac{1}{2}$	90	4 0	4 0	1 7	$\frac{3}{4}$	38	33	39	41	34	41	42
$2\frac{1}{4}$	135	4 0	4 0	1 7	$1\frac{1}{2}$	75	38	38	41	38	40	42
$2\frac{1}{4}$	135	4 0	4 0	1 7	$1\frac{1}{2}$	95	43	38	41	43	40	42
$1\frac{1}{2}$	90	4 0	4 0	1 7	$\frac{3}{4}$	38	38	38	41	38	40	42
$1\frac{1}{2}$	90	4 0	4 0	1 7	$\frac{3}{4}$	38	41	39	41	42	41	42
$1\frac{1}{2}$	90	4 0	4 0	1 7	$\frac{3}{4}$	38	42	40	41	43	42	42
2	120	4 0	4 0	1 6	1	50	41	40	41	41	42	42
3	180	4 0	4 0	1 5	$2\frac{1}{4}$	110	42	40	42	42	42	43
3	180	3 $11\frac{1}{2}$	3 $11\frac{1}{2}$	1 4	$2\frac{1}{4}$	110	42	41	42	43	43	43
..	5,850	..	..	..	..	3,310	..	..	..	..	..	..
..	12,697	..	..	..	..	15,237	..	..	..	..	..	..
..	18,547	..	..	..	..	18,547	..	..	..	..	..	..

HINXWORTH DRAINAGE.—RECOR

Day of the Month.	1 Rainfall. Per Diem. Inches dec.	2 Rainfall. Per Acre. (Per Diem.) In Gallons.	3 Barometer. Height at the time of recording the Discharge from the outlets, 8 o'clock, A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	4 Occasional Drainage. Field No. 40.—16 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining. Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep. Higher Side. Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in. (ft.)	(in.)	5 Lower Side. Distance from Drain to Drain 33 yds. Depth of Drains 6 ft. (ft.)	(in.)	6 Quantity of Water from Outlet No. 8, which discharges the Drain-water from Field No. 40. Per Minute. In Gallons.	7 Per Acre. In Gallons (per diem).	8 Part Occasiona and part Wide Parallel Drainage. 18 Acres.—Soil, sam as last in part of fiel remainder Gault an Gravel mixed. Quantity of Wat from Outlet No. which discharges th Drain-water fro No. 22. Size of Pip five inches. Com menced running O tober 12. Per Minute. In Gallons.	9 Per Acr In Gallo (per die
1	·050	1,131	29·37	5	3	5	6	¾	67	2¼	18
2	..	..	29·15	5	3	5	6	¾	67	2¼	18
3	·015	339	29·48	5	3½	5	6	¾	68	2¼	18
4	·060	1,357	29·67	5	4	5	6	¾	68	2¼	18
5	·460	10,406	29·69	5	6	5	6	3	270	9	72
6	·035	792	29·58	5	8	5	5	3	270	9	72
7	..	..	29·80	5	8	5	5	3	270	6	48
8	..	..	29·89	5	8	5	5	3	270	6	48
9	·005	113	29·58	5	8	5	6	3	270	5¼	42
10	·080	1,810	29·48	5	8	5	6	2¼	200	4½	36
11	·030	678	29·40	5	8	5	6	2¼	200	3¾	30
12	·035	772	29·35	5	8	5	6	3	270	3¾	30
13	·300	6,786	29·87	5	8	5	6	3¾	338	5¼	42
14	·150	3,394	29·20	5	8	5	5½	3	270	8¼	66
15	·005	115	29·46	5	8	5	5½	3	270	6	48
16	..	..	29·65	5	8	5	5½	3	270	5¼	42
17	·005	110	29·83	5	8½	5	6	3	270	4½	36
18	..	..	29·83	5	8½	5	6	3	270	4½	36
19	..	..	29·78	5	8½	5	6½	2½	215	4½	36
20	..	..	30·10	5	8½	5	6½	2¼	200	4½	36
21	..	..	30·18	5	9	5	7	2¼	200	4½	36
22	..	..	30·00	5	8½	5	6	3	270	5¼	42
23	·205	4,650	29·90	5	8	5	5	3	270	5¼	42
24	..	..	30·76	5	9	5	6	3	270	3¾	30
25	..	..	29·69	5	10	5	6	3	270	3¾	30
26	·005	113	29·80	5	10	5	6	2½	225	3	24
27	..	..	30·00	5	10	5	6	2¼	200	3	24
28	..	..	30·03	5	10	5	6	2¼	200	3	24
29	..	..	30·00	5	10	5	6	2¼	200	3	24
30	..	..	30·00	5	10	5	6	2¼	200	3	24
Total	1·440	32,566		Total quantity of Water per Acre discharged					6,698	..	10,92
				Remainder unaccounted for ..					25,868	..	21,64
				Total Rainfall ..					32,566	..	32,56

[O]F THE MONTH OF APRIL, 1857.

10	11	12	13	14	15	16	17	18	19	20	21	22
[P]ARALLEL DRAINAGE. [F]ields 13 and part 14.—24 Acres. Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.					TEMPERATURE. At half-past Seven, A.M.					
[Q]uantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Holes 5 feet deep.			Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.		Undrained Land.			Drained Land.		
		Drained Land.										
[P]er Minute. [I]n Gallons.	Per Acre. In Gallons (per diem).	Higher Side. 25 ft. apart and 4 ft. deep. No. 31.	Lower Side. 25 ft. apart and 4 ft. deep. No. 31.	Undrained Land. No. 33.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem)	Of Air 9 Inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
1½	90	3 11½	3 11½	1 3	2¼	110	45	41	42	45	43	43
1½	90	3 11½	3 11½	1 3	1½	75	46	42	42	49	44	43
1½	90	3 11½	3 11½	1 3	1½	75	48	42	42	47	44	43
1½	90	4 0	4 0	1 3½	¾	37	47	43	42	48	45	43
13½	810	4 0	3 11½	1 3	8¼	410	44	44	43	45	46	44
13½	810	4 0	3 11	1 2	8¼	415	42	45	43	46	47	44
12	720	4 0	3 11	1 2	7½	375	45	46	43	46	48	44
10½	630	4 0	3 11	1 3	6	300	46	46	44	47	48	45
7½	450	4 0	3 11	1 4	5¼	265	44	46	44	45	48	45
6¾	405	4 0	3 11	1 5	4½	225	45	47	44	44	49	45
6	360	4 0	4 0	1 5	3¾	185	44	47	44	45	49	45
6	360	4 0	4 0	1 4	4¼	200	45	46	44	46	48	45
8¼	495	4 0	4 0	1 4	5¼	265	42	45	44	42	47	45
15	900	4 0	4 0	1 4	11¼	560	37	44	44	37	45	45
9	540	4 0	4 0	1 4	5¼	265	41	43	44	41	44	45
7½	450	4 0	4 0	1 4	4½	225	43	43	44	43	44	45
6	360	4 0	4 0	1 4	4½	225	44	42	44	44	43	45
5¼	315	4 0	4 0	1 4	4½	225	46	43	44	46	44	45
4½	270	4 0	4 0	1 4	4½	225	43	44	44	43	45	45
4½	270	4 0	4 0	1 4	4½	225	42	44	44	42	46	45
3¾	225	4 0	4 0	1 4	3¾	185	42	45	44	42	47	45
4½	270	4 0	4 0	1 4	3¾	185	40	46	45	40	48	46
4½	270	3 11½	4 0	1 3	3¾	185	38	46	45	39	48	46
4½	270	3 11	4 0	1 3	3	148	37	46	45	38	48	46
3¾	225	3 11½	4 0	1 3	3	148	43	45	45	43	47	46
3	180	4 0	4 0	1 3	2¼	110	39	44	45	39	46	46
3	180	4 0	4 0	1 3	2¼	110	37	43	45	37	45	46
2¼	135	4 0	4 0	1 3	1½	75	38	42	44	38	44	45
2¼	135	4 0	4 0	1 3	1½	75	41	42	44	41	44	45
2¼	135	4 0	4 0	1 3	1½	75	40	42	44	40	44	45
..	10,530	..	..	..	..	6,183	..	..	..	..	..	..
..	22,036	..	..	..	..	26,378	..	..	..	..	..	..
..	32,566	..	..	..	..	32,566	..	..	..	..	..	..

HINXWORTH DRAINAGE.—RECO

	1	2	3	4	5	6	7	8	9
	RAINFALL.		BAROMETER.	OCCASIONAL DRAINAGE. Field No. 40.—16 Acres. Soil, lower Chalk mixed with Clay, Gravel, and Sand. Very wet before Draining.				PART OCCASIO[N] AND PART WIDE PARALL[EL] DRAINAGE. 18 Acres.—Soil, s[ame] as last in part of f[ield] remainder Gault [and] Gravel mixed.	
				Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes which are sunk midway between the occasional Drains. Test Holes 8 feet deep.		Quantity of Water from Outlet No. 8, which discharges the Drain-water from Field No. 40.		Quantity of W[ater] from Outlet No [...] which discharges Drain-water f[rom] No. 22. Size of [...] five inches. C[om]menced running [Oc]tober 12.	
Day of the Month.	Per Diem. Inches dec.	Per Acre. (Per Diem.) In Gallons.	Height at the time of recording the Discharge from the outlets, 8 o'clock, A.M. *Note.*—It should be observed that the height recorded is simply the height of the mercury at a certain time of day.	Higher Side. Distance from Drain to Drain 75 yds. Depth of Drains 7 ft. 6 in.	Lower Side. Distance from Drain to Drain 33 yds. Depth of Drains 6 ft.	Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Per Minute. In Gallons.	Per A[cre]. In Ga[llons] (per d[iem]).
1	·040	905	30·07	5 10½	5 6	1½	135	3	2
2	·005	113	30·06	5 11	5 6	1½	135	3	2
3	..	..	30·17	5 11	5 6	3	270	3	2
4	..	..	30·18	5 11	5 6	3	270	3	2
5	..	..	30·19	5 11	5 6	3	270	3	2
6	·010	226	30·20	5 11	5 6	3	270	3	2
7	..	..	30·19	5 11½	5 6½	2¼	200	2¼	1
8	..	..	30·05	5 11½	5 6½	2¼	200	2¼	1
9	..	..	29·79	6 0	5 6½	2¼	200	2¼	1
10	..	..	29·68	6 1	5 6½	1½	135	2¼	1
11	·150	3,393	29·60	6 1	5 6½	1½	135	2¼	1
12	·050	1,131	29·80	6 1	5 6½	1½	135	3	2
13	·010	226	30·00	6 1½	5 6	1½	135	3	2
14	..	..	30·00	6 2	5 7	1½	135	2¼	1
15	..	..	30·01	6 2½	5 7	1½	135	2¼	1
16	·055	1,245	30·10	6 3	5 7	1½	135	2¼	1
17	..	..	30·09	6 3½	5 7½	1½	135	1½	1
18	..	..	30·00	6 3½	5 7½	1½	135	1½	1
19	..	..	29·95	6 4	5 8	¾	67	1½	1
20	..	..	29·80	6 4½	5 8½	¼	23	1½	1
21	..	..	29·60	6 5	5 9	¼	22	1½	1
22	·040	905	29·76	6 5	5 9½	Nil	Nil	1½	1
23	·170	3,845	29·60	6 6	5 10	Nil	Nil	2	1
24	·030	678	29·41	6 6	5 11	1½	135	1½	1
25	..	..	29·46	6 6	6 0	1½	135	1½	1
26	·180	4,074	29·48	6 6	6 3	1½	135	1½	1
27	..	..	29·64	6 6½	6 3	1½	135	1½	1
28	..	..	29·70	6 6½	6 4	1	90	1	
29	..	..	29·80	6 7½	6 5	1	90	1	
30	·010	226	29·89	6 7½	6 6	1	90	1	
31	..	..	29·95	6 8	6 6½	1	90	1	
Total	·750	16,967	..	Total quantity of Water per acre discharged			4,177	..	5,0
				Remainder unaccounted for ..			12,790	..	11,9
				Total Rainfall ..			16,967	..	16,9

OF THE MONTH OF MAY, 1857.

10	11	12		13		14		15	16	17	18	19	20	21	22
PARALLEL DRAINAGE. Fields 13 and part 14.—24 Acres. Soil, Gault Clay, with Lime infiltrated. Patches and veins of Sand found giving vent to under water which has run through the Summer of 1856.		CLOSE PARALLEL DRAINAGE. Fields Nos. 31, 32, and 33. Nos. 31 and 32 only drained.—29 Acres. No. 33 undrained. Soil, Gault Clay, with Lime infiltrated. Considered very stiff and impenetrable. Drains, 25 feet apart, and 4 feet deep.								TEMPERATURE. At half-past Seven, A.M.					
Quantity of Water from Outlet No. 13, which discharges the Drain Water from Nos. 13 and part 14. Size of Pipe 5 inches. Has run throughout the year.		Observations on Test Holes, being the depth of free soil from surface of Land to surface of Water in the Holes, which are sunk midway between the Drains. (See also Temperature.) Test Holes 5 feet deep.						Quantity of Water from Outlet No. 15, which discharges the Drain Water from Nos. 31 and 32. Size of Pipe 7 inches. Commenced running November 27.		Undrained Land.			Drained Land.		
Per Minute. In Gallons.	Per Acre. In Gallons (per diem.)	Drained Land. Higher Side. 25 ft. apart and 4 ft. deep. No. 31.		Drained Land. Lower Side. 25 ft. apart and 4 ft. deep. No. 31.		Undrained Land. No. 33.		Per Minute. In Gallons.	Per Acre. In Gallons (per diem).	Of Air 9 inches above surface. No. 33.	Of Soil 18 in. below ground. No. 33.	Of Soil 42 in. below ground. No. 33.	Of Air 9 in. above surface. No. 31.	Of Soil 18 in. below ground. No. 31.	Of Soil 42 in. below ground. No. 31.
2¼	135	4	0	4	0	1	3½	1½	74	42	42	44	42	44	45
2¼	135	4	0	4	0	1	4	1½	74	44	43	44	44	45½	45
2¼	135	4	0	4	0	1	4	1½	74	43	43	45	43	45½	46
2¼	135	4	0	4	0	1	4	1½	74	44	43	45	44	45½	46
2¼	135	4	0	4	0	1	4	1½	74	41	44	45	41	46	46
1½	90	4	0	4	0	1	4½	1½	75	38	43	45	39	45	46
1½	90	4	0	4	0	1	4½	1½	75	38	43	45	38	45	46
1½	90	4	0	4	0	1	5	¾	37	40	43	45	40	45½	46
1½	90	4	0	4	0	1	5	¾	37	45	44	45	45	46	46
2	120	4	0	4	0	1	5	1	49	44	44	45	44	46	46
2¼	135	4	0	4	0	1	5	1½	75	47	45	45	48	47	46
2¼	135	4	0	4	0	1	5	1½	75	49	46	45	50	48	46
3	180	4	0	4	0	1	5	1½	75	52	48	45	53	50	46
2¼	135	4	0	4	0	1	5½	1½	75	53	49	46	54	51	47
1½	90	4	0	4	0	1	6	2¼	110	56	51	47	56	53	48
1½	90	4	0	4	0	1	6	2¼	110	58	52	48	58	55	49
¾	45	4	0	4	0	1	6	2¼	110	58	52	48	58	55	49
1	60	4	0	4	0	1	6	2¼	110	60	51	48	60	54	49
1	60	4	0	4	0	1	6	2¼	110	63	50	48	63	53	49
¾	45	4	0	4	0	1	6	2¼	110	63	51	48	64	54	50
¾	45	4	0	4	0	1	6½	2¼	110	65	54	49	65	56	51
¾	45	4	0	4	0	1	6½	2¼	110	66	54	50	66	56	51
1	60	4	0	4	0	1	6	3	148	64	54	50	63	56	51
1	60	4	0	4	0	1	6	3½	173	61	54	50	62	56	51
1	60	4	0	4	0	1	6	3¾	185	60	54	50	61	56	51
1½	90	4	0	4	0	1	6	4	198	61	54	49	60	55	51
1½	90	4	0	4	0	1	6	4	199	62	53	49	62	55	52
1	60	4	0	4	0	1	6½	3¾	185	62	53	50	61	56	52
¾	45	4	0	4	0	1	6½	3¾	185	61	53	50	60	56	52
¾	45	4	0	4	0	1	7	3	149	62	53	49	62	56	52
¾	45	4	0	4	0	1	7	3½	173	..	..	..	..	..	..
..	2,775	..		..		..		..	3,418	..	..	..	..	..	..
..	14,192	..		..		..		..	13,549	..	..	..	..	..	..
..	16,967	..		..		..		..	16,967	..	..	..	..	..	..

Summary of the Foregoing Records.

Months.	Rainfall.		Quantities Discharged from Outlets.				Months.
	Inches.	Per Acre. In Gallons.	From Outlet No. 7, from Oct. 1 to Feb. 28, and from Outlet No. 8, from March 1 to May 31 as per col. 7. Per Acre in Gallons.	From Outlet No. 9, as per col. 9. Per Acre in Gallons.	From Outlet No. 13, as per col. 11. Per Acre in Gallons.	From Outlet No. 15, as per col. 16. Per Acre in Gallons.	
October	1·645	37,215	12,910	178	9,075	Nil	October.
November	1·630	36,872	27,000	2,077	6,015	330	November.
December	1·235	27,935	30,135	11,895	16,095	5,825	December.
January	2·333	52,775	43,855	39,090	49,250	31,805	January.
February	·192	4,343	27,360	14,320	13,650	9,060	February.
March	·820	18,547	From Outlet No. 8, at a higher level 8,415	7,830	5,850	3,310	March.
April	1·440	32,566	6,698	10,920	10,530	6,183	April.
May	·750	16,967	4,177	5,040	2,775	3,418	May.
Total Rainfall ..	10·045	227,220	160,550	91,350	113,240	59,931	Total discharge per Acre.
Difference between Rainfall and Discharge from the Drains ..			66,670	135,870	113,980	167,289	
			227,220	227,220	227,220	227,220	Total Rainfall.

absorbent demands of the clays, a large proportion of any succeeding rain was immediately discharged by the underdrains. There was a fall of rain at Hinxworth in October, 1856, of 1·645, and in November of 1·630, equal together to a supply to the soil of 74,087 gallons, or 330 tons of water per acre. The drains just began to trickle on the 27th of November, after a fall of half an inch of rain (·540). The test holes in the land showed that the soil was rapidly feeding itself and that the water level was rising, but had not reached the level of the drains. On the 12th December, the outlets were running 160 gallons per diem per acre after frequent rains in the early part of the month of less than a tenth of an inch per diem. On the 13th, the rain-gauge showed a fall of ·452 (nearly half an inch), and the outlets increased their discharge from 160 gallons to 975 gallons per diem per acre. On the 9th January, 1857, the outlets were running 125 gallons per diem. On the 10th, the rain-gauge showed a fall of ·542 (rather more than half an inch), and the discharge from the outlets was increased from 125 gallons to 5,150 gallons per diem per acre. How important are these facts in considering the effect of extended under-drainage on the arterial channels of the country!

IV. Height of standing water in the Soil before and after Drainage.—The effect of the different modes of draining in lowering the water-level in each descriprion of soil is shown by the height of the water standing in the test holes (dug midway between the drains), at columns 4, 5, 12, and 13.

V. Temperature.—The temperature of the air above and of the soil below the surface, before and after drainage, is shown in the last 6 columns, and a remarkable proof of the influence and penetration of atmospheric changes through the soil to the depth of drains is to be seen in the fact, that all the outlets discharged an increased quantity of water on the 6th of March and 22nd of April, without any fall of rain on the surface, it being observed on each occasion that a very considerable fall of the barometer had taken place within the previous twenty-four hours.

Concluding Observations.—The drainage of Hinxworth, commenced in 1856, was brought to a close early in 1858. The heaviest portion, 300 acres of the gault clay, was taken early in hand, and has been up to this time held, by Mr. Clutterbuck himself. During this comparatively short period the homestead has been remodelled, convenient roads of burnt clay-ballast have been made, and the old high-backed lands (the custom of the country) have been reduced to an even surface, without water-

furrows. All useless hedges have been removed, old ditches and water-courses filled up, and the arable land has been deeply cultivated and well cleaned.

Under this treatment the improvement in the texture of the soil and the character both of white straw and green crops has more than realized my expectations.

I had the satisfaction during the past week of inspecting the estate. The outlets from the clay-lands were then discharging at the rate of 2700 gallons per acre per diem, and I was informed by Mr. Scott, the bailiff, that during the late heavy rains no water had stood upon the surface.

I am induced to hope that the publication of these results may tend to remove any local prejudice which may still attach to undrained land of as unpromising a character as that of Hinxworth, more especially as I am permitted to add, that the clay-land farm has been let within a few days on terms securing a full return for the capital expended in draining, and the several judicious improvements carried out by Mr. Clutterbuck, to which I have already alluded.

52, *Parliament Street, Westminster,*
December 30*th*, 1859.

XVI.—*On Cross Breeding.* By W. C. Spooner, M. R. C. V. S.

It cannot be denied that the natural laws by which the preservation of animal species is effected are involved in considerable mystery, and though the subject is well worthy the attention and study of the practical man as well as of the physiologist, experience is yet fraught with so much contrariety that attempts to lay down any certain guide on it have for the most part been received with considerable distrust. No sooner does the inquirer imagine that he has discovered some particular principle which obtains universally, than he is met by circumstances which apparently upset his previous conclusions. The maxim "*like begets like,*" for example, is a rule having very extensive sway, yet, as propagation is the work of two parents, the respective influence of the one or the other is a matter involving considerable diversity of opinion, and prevents anything like a certain conclusion being arrived at. We cannot do better than consider, on the very threshold of our subject, the respective influence of either parent; for on this the merits of pure or cross breeding must principally depend. The most probable supposition is, that propagation is done by halves, each parent giving to the offspring the shape of

one half of the body. Thus the back, loins, hind-quarters, general shape, skin, and size, follow one parent; and the fore-quarters, head, vital and nervous system, the other: and we may go so far as to add, that the former in the great majority of cases go with the male parent, and the latter with the female. A corroboration of this fact is found in the common system of putting an ordinary mare to a thorough-bred horse; not only does the head of the offspring resemble the dam, but the forelegs likewise, and thus it is fortunately the case that the too-frequently faulty and tottering legs of the sire are not reproduced in the foal, whilst the full thighs and hind quarters which belong to the blood-horse are generally given to the offspring. There is, however, a minority of cases in which the opposite result obtains. That *size* is governed more by the male parent, there is no great difficulty in showing;—familiar examples may be found in the offspring of the pony-mare and the full-sized horse, which considerably exceed the dam in size. Again, in the first cross between the small indigenous ewe and the large ram of another improved breed—the offspring is found to approach in size and shape very much to the ram. The mule offspring of the mare also very much resembles both in size and appearance its donkey sire.

These are familiar examples of the preponderating influence of the male parent, so far as the external form is considered. To show, however, that size and height do not invariably follow the male, we need go no further for illustration than the human subject. How often do we find that in the by no means infrequent case of the union of a tall man with a short woman, the result in some instances is that all the children are tall and in others all short, or sometimes that some of the family are short and others tall. Within our own knowledge, in one case, where the father was tall and the mother short, the children, six in number, are all tall. In another instance, the father being short and the mother tall, the children, seven in number, are all of lofty stature. In a third instance, the mother being tall and the father short, the greater portion of the family are short. Such facts as these are sufficient to prove that height or growth does not exclusively follow either the one parent or the other. Although this is the case, it is also a striking fact that the union of tall and short parents rarely, if ever, produces offspring of a medium size—midway, as it were, between the two parents. Thus, in the breeding of animals, if the object be to modify certain defects, by using a male or female in which such defects may not exist, we cannot produce this desired alteration; or rather, it cannot be equally produced in all the offspring, but can only be attained by weeding out those in whom the objectionable points are repeated.

We are, however, of opinion that, in the majority of instances, the height in the human subject, and the size and *contour* in animals, is influenced *much more by the male* than the female parent; and, on the other hand, that the constitution, the chest, and vital organs, and the forehand generally, more frequently follow the female.

We have dwelt on this point the more because on it hinges the difficulty of effecting certain improvements in breeding by means of crossing, and the still greater difficulty of establishing a new breed by such means. So great is this difficulty that many breeders, finding their attempts at such improvements so frequently baffled, or observing this to be the case in the practice of others, cling with superstitious tenacity to the doctrine of *purity of blood*, believing it to be the *Ark* in which alone true safety is to be found.

Now *pure breeding*, which, when carried to an excess, is called in-and-in breeding, has its advantages as well as its disadvantages. Its friends observe with great force, that when we have in breeding reached great excellence, it is folly to risk the loss of such excellence by means of crossing; and the more so as the defects of a parent may disappear in a first or second, and reappear in the third or fourth generation; "*breeding back*," as it is commonly termed. A friend of the writer's, Mr. John Clark, of Lockerly, a strenuous advocate of pure breeding, observes that a correspondent in Suffolk informs him, that he had seen the cross tried between the old Norfolk and Down sheep, and the first cross was admirable, but they soon became disproportioned and unsightly; also the Down and Leicester in some midland counties figured for a time, and then for the same reasons were given up, and such he thinks will be the fate of the New Oxfords, or the mixture of the Cotswold and the Down. He adds, that for the last four years he has used rams from the cross with Down ewes, and the offspring have answered his purpose for *fatting* lambs, but one lamb in ten presents unmistakeable evidence of its mongrel origin.

Again, it is urged that great excellencies can only be perpetuated by union with similar excellencies, and beyond all this that there is a certain amount of advantage from an unstained lineage—from the very possession of breed, as it is designated. The objectors to *in-and-in* breeding urge, that by so doing we engender weakness of constitution, diminution of size, hereditary diseases, and also a tendency to barrenness; but it is argued in reply to such objections, that they occur from want of sufficient care in weeding out defective animals, whether as respects constitution or size. It is a well-established fact, that in

the human subject too close affinity, such as the intermarriage of cousins, tends to mental diseases and consumption; and we can readily imagine that when there is a tendency to such diseases in a family, this tendency must be greatly increased by intermarrying with a member of the same family. Animals not being subject to mental diseases, the observation does not apply to them with the same force, but it is true in a lesser degree. At the same time, unless the choice is extremely confined, most of the evils of pure breeding can be avoided by careful selection and rigorous weeding. Examples of pure breeding are familiar to us in the admired race-horse, the first-class short-horn, and the South-down sheep; but, so far as purity of breed alone is considered, the mountain sheep of Wales, the Highland Scotch cattle, and the Shetland or Welch, are equally pure; but whilst the latter have been propagated without care or attention, the former have, by careful selection and rigorous weeding, been considerably enhanced in value. A striking example of long continued pure breeding is afforded by the Leicester flock of Mr. Valentine Barford, of Foscote near Towcester, who has the pedigree of his sheep from the day of Bakewell in 1783 to the present time, and since 1810 he has bred entirely from his own flock, sire and dam, without an interchange of male or female from any other flock. He observes, "that his flock being bred from the nearest affinities—commonly called in-and-in breeding—has not experienced any of the ill effects ascribed to the practice." His flock is remarkably healthy, and his rams successful, but his sheep are small.

Let us pause for a few minutes to consider what constitutes *breed*, or rather what is meant by high breeding. We shall find that it refers to very different desiderata in different breeds. In the thorough-bred horse it signifies a very high development of the muscular and nervous systems, accompanied by such mechanical structure as when united with it constitutes the highest manifestation of speed and endurance. In the ox, however, it implies very different qualities, viz., early and rapid growth—the development of flesh or muscle on the parts most prized for food—a disposition to lay on fat; these, with the possession of the smallest amount of bone consistent with strength and health, are the principal characteristics of a well-bred animal. Instead of the highly-nervous temperament of the race-horse, we have here a quiet lazy disposition; in fact, a lymphatic temperament, by the influence of which the digestive organs reign supreme, and convert for the public benefit a given quantity of food into the utmost amount of flesh and fat. The same observations apply with equal force to the sheep, and in a still stronger degree to the pig. A well-bred pig is the incarna-

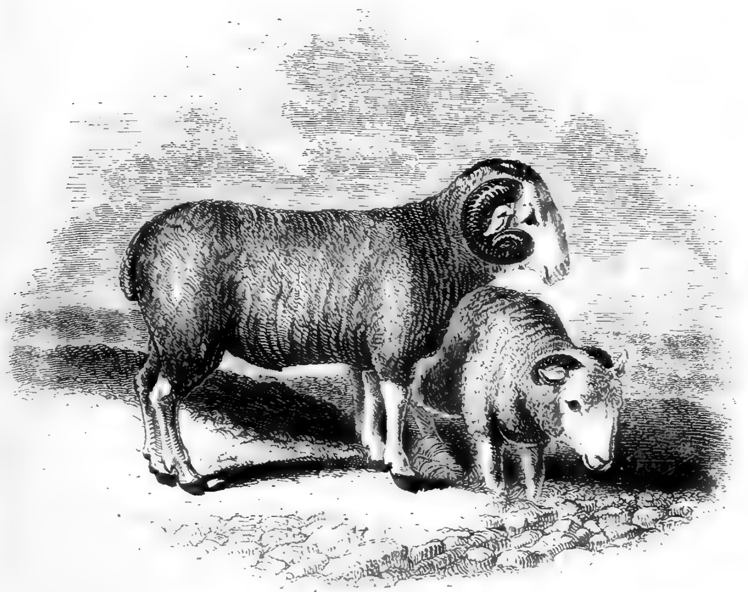
tion of everything indolent and lethargic, and the very antipodes of that high organization and nervous development which belong to a high-bred horse. Examples of pure breeding are probably to be found in greater perfection in cattle than in sheep. The *Devon* and *Hereford* cattle have descended through many generations in unbroken lines, and owe the perfection which they have attained to careful selection. The *Short-horns*, although considerably more modern in their origin, and moulded into their present form by a series of successful crosses, have yet been preserved pure with even more rigorous care than the other breeds which we have mentioned. The solid frame and great feeding properties of the Herefords—the quality of beef and richness of cream, as well as working properties of the Devons, are well known and generally appreciated; and yet these qualitie sare insufficient to resist successfully the encroachments of the Short-horns, whose early maturity and disposition to lay on both flesh and fat, joined with fair milking properties, are such that they outnumber both the other breeds combined. As, however, the leading purpose for which a breed of cattle is kept is generally well defined, whether for the purpose of the dairy, or for that and early fatting, or simply for beef or for working as well, and, as each of these purposes can be well attained by keeping a pure breed, there is not the same temptation or inducement to cross, which is often experienced in sheep-farming, in order to insure specific advantages which cannot otherwise be attained.

This being the case, we may most advantageously devote our remaining space to the practice of crossing, as illustrated in sheep-breeding. We may start, then, with this principle, that to cross for crossing sake is decidedly *wrong;* that, unless some specific purpose is sought for by crossing, it is far better to cultivate a pure breed. The country is, indeed, under great obligations to those gentlemen who carefully preserve their breed intact, and endeavour to improve it by weeding and selection. We can readily excuse their prejudices, if they have any, and have no wish to interfere with their creed. Let theirs be the office to preserve our fountains pure and undefiled, and to supply others with the best sources of improvement by crossing. And we do not confine our praise to those merely who, keeping in the high road of fashion, have succeeded in securing, both by prizes and prices, a full and sufficient reward for their labours, but would award it to those also who, keeping perhaps in the second rank, have yet supplied their neighbours and the public with valuable pure-bred sheep at moderate prices.

History fails to supply us with the origin of our various breeds of sheep; but we doubt not that, for many centuries after

the time of the Romans in this country, certain distinct breeds were perpetuated, with little improvement and little change. The progenitors of the present Southdown or Sussex breed, inferior as they were to their descendants, ranged probably, in the days of the Romans, over the Southdown hills; whilst another breed, now happily extinct, occupied for the most part the hills and downs of Wiltshire and Hampshire. A large, bony, narrow, but active sheep, with large heads, Roman noses, and long curly horns, high in the withers and sharp in the spine, but yet the largest short-woolled breed in existence, were the denizens of these counties during the last century.

In Wiltshire, although they remained as a pure breed much longer than in Hampshire, yet, as far as can be learnt, they were supplanted by the Southdown, whose superior qualities displaced the old Wiltshire altogether; and we are not aware of any instances in which they were crossed, except for the purpose of crossing them out by using again and again the Sussex ram. Mr. James Rawlence of Bulbridge, near Wilton,



THE OLD WILTSHIRE SHEEP.—1. Ram bred by Mr. Porter, Hindon, Wilts. 2. Ewe from the same flock. For sheep of any of the other pure or cross breeds mentioned in this Essay the reader is directed to the show-yard at any of our agricultural meetings. The old Wiltshire sheep is, however, now extinct; and the above engraving is therefore given of it. It has been reduced, by permission of Messrs. Longmans, the publishers, from a plate in Professor Lowe's work 'On Domesticated Animals.'

whose large practical experience, both as sheep-breeder and land-agent, stamps his authority with considerable weight, observes in reply to the author's inquiry, "The last flock of this breed (old Wiltshire) disappeared about the year 1819, and the substitution of the Southdown commenced late in the last century. In many cases Southdown ewes as well as rams were brought out of Sussex to replace the horned flocks, but in numerous instances the two breeds of sheep were crossed, and by the continued use of the Southdown ram the chief characteristics of the horned breed were merged in the Downs. The cause of the very rapid substitution of the Down for the Old Wiltshire may be found in the fact of the large number of enclosures of common fields which then took place. The sturdy horned wether was thoroughly competent to take care of himself when the system of feeding in common prevailed, but when each farmer could keep his flock separate, an animal of superior quality was preferred."

In Hampshire, on the other hand, where the same sheep prevailed and were valued for their hardihood, and their powers of travelling far, and folding hard—properties so valuable when the fertility of the light soils was mainly kept up by these useful manure-carriers — these sheep were extensively crossed. Previous to the close of the last century, the South-down sheep had been greatly improved by careful selection, and the name of the late Mr. Ellman was well known for his eminent services in bringing out and improving the latent qualities of this valuable breed. About the beginning of the present century the sheep-breeders of North Hampshire began to bestir themselves, and a few enterprising farmers procured some rams from Sussex, of the Southdown breed. Finding the experiment successful, it was repeated again and again, care being taken to select the largest, coarsest, and *blackest*-faced rams, which it was thought would suit the coarse sheep with which they had to amalgamate. How many crosses with the pure Sussex were used we cannot ascertain, but enough materially to alter the character of the breed, to cause the horns to disappear, and to change the colour of the face from white to black; and, with these changes, to impart a more compact frame, a broader back, rounder barrel, shorter legs, and superior quality altogether, and yet preserving the hardiness and the disposition to make early growth, which the original flock no doubt possessed, and with it the large heads and Roman noses, which form so distinguishing a characteristic of the Hampshire Downs, and which are unquestionably derived from the original breed. Indeed, it is only necessary to inspect a drawing of the original Hampshire or Wiltshire sheep to become thoroughly satisfied as to the source from whence is derived the colossal head which some fifteen years since was

regarded as, I will not say an ornament, but an indispensable appendage of the breed. Uniformity of colour is also a great point with most Hampshire breeders, with what amount of advantage we cannot say, but black tips to the ears as well as black faces are deemed essential, and any crossing with speckled-faced sheep, such as the Shropshire, is in consequence viewed with dislike.

It was not until the Wiltshire sheep-breeders began to produce some large but more symmetrical animals that the Hampshire men began to consider whether it was not possible to reduce the size of the heads, without losing the characteristics of the breed. By attention and careful selection this has been accomplished, and we have now a breed of sheep which is admirably adapted to the present system of fatting off at much earlier ages than formerly, and, for the most part, as tegs and two-teeth sheep. It is certainly not owing to any aristocratic patronage that the Hampshire sheep have forced their way into public estimation. They have neither been upheld by agricultural societies or agricultural writers, nor have they been launched into public favour as winners of prizes; on the contrary, they have been laughed at, criticised, and condemned; and yet they have not only held their own, but have spread far and near, so that the county in South England where none are to be found is probably the exception, not the rule. The Hampshire sheep may, therefore, be instanced as an example of successful crossing, and as a proof of what can be done by the male parent, in changing, in very few generations, the character of the original, and yet retaining some of its good qualities, thus forming a breed more intrinsically valuable than either source from whence it is derived. It has been truly said that the public is wise though composed of fools; and undoubtedly, when the pocket is concerned, the decision of the public is, for the most part, correct. Thus at the various autumnal fairs large lambs are in the greatest request, and command the highest prices, which in itself is a sufficient proof that with a given amount of food they make a greater quantity of mutton. It was found indeed by Mr. Lawes, in his careful and valuable experiments, that the Hampshire sheep, although they were surpassed by the Cotswold, yet exceeded the Southdown in the amount of mutton raised from a given weight of food. The greater economy of fatting a young over an old animal may be readily explained by the fact, that whilst the latter increases in fat alone, the former does so both in flesh, fat, and bone, and thus the latter can assimilate a greater amount of the nutritious properties of the food, and is consequently a more profitable feeder.

We have no reason to suppose that after a few generations the Hampshire breeders continued to use the Sussex rams; as soon as the horns were gone, to which, perhaps, the Berkshire Notts contributed, and the face had become black, they employed their own cross-bred rams with the cross-bred ewes. If, then, we were asked what original blood predominated in the Hampshire sheep, we should unquestionably say the Sussex; but if the further question were put, Is the present breed derived from the Sussex and the original Hampshire alone? we should express a doubt as to such a conclusion, as there is good reason to consider that some improved Cotswold blood has been infused. Some thirty years since a Hampshire farmer still living (Mr. John Twynam) used the improved Cotswold ram with his Hampshire ewes, and the first cross exhibited a remarkable proof of the preponderating effect of the male. The produce, in size, general appearance, and wool, partook far more of the ram than of the ewe, and it was thought that a most valuable breed had been obtained, which, with the increased size, and weight of fleece, and disposition to fatten of the Cotswold, would combine the hardiness and folding capabilities of the Hampshire. It was found, however, no easy task to perpetuate such a breed after the first cross—the defects of the one parent or the other would appear and reappear in the second and third generation, and it was only by careful weeding that anything like uniformity could be attained. Mr. E. G. Young, of Broadchalk, Wilts, a close observer as well as an excellent farmer, informs the writer that he, as well as his brother, purchased Mr. Twynam's rams for several years, and has, he conceives, derived advantage from the cross. Mr. Rawlence observes, that the points he has arrived at have been to produce an animal yielding at an early age the largest possible amount of mutton and wool, which he considers the *sine quâ non* of sheep breeding; and he adds, it is difficult to estimate the enormous increased production which has within the last few years been obtained by keeping this object steadily in view. Whilst he highly appreciates the high-bred Southdown, he is convinced that the present system of farming demands a larger description of sheep, and one which will produce a heavy weight of wool at an earlier age, and he is not quite sure whether a cross with Cotswold would not produce a more profitable animal. The absurd fashion of drafting good sheep, if they have not black faces and ears, tends to retard the improvement of the carcase. After some few years a change of farm and other causes led to a discontinuance of the experiment, yet many of the cross-bred rams were sold and let to sheep-breeders both in Hamp-

shire and Wiltshire; and although after dipping once or twice into this breed they then ceased to do so, yet they have continued breeding from descendants of the cross, and thus, in very many of the Hampshire and the Wiltshire flocks, there is still some improved Cotswold, and, consequently, Leicester blood.* Probably an increase of wool has thus been obtained. Some say that on the borders of Berkshire the Berkshire Nott was also used, and others contend, although without proof, that a dip of the Leicester has been infused. Be this as it may, there is no doubt that, although for some years past the Hampshire sheep have, for the most part, been kept pure, yet they have been very extensively crossed with other breeds before this period.

We cannot do better than let Mr. Twynam speak for himself on a matter on which he has bestowed considerable attention during a period of ten or twelve years. In a paper he has recently read before a Farmers' Club—after some observations on the respective merits of the Cotswold, the Leicester, the Southdown, and the Old Wiltshire, or Hampshire, from all which sources the present breed is derived—he states that his idea was to blend these various breeds together, which he did by using the improved Cotswold ram (Cotswold and Leicester) with the Hampshire Down ewe. As a proof of the value of the cross, he observes,—"I have the written documents of the feeder of one hundred tegs sold in 1836, the wool and carcases from which returned 400*l.*" By using this cross an earlier maturity is gained than by either breed separately. He observes:—"The Leicester and Cotswold will become large, heavy, and fat on the outside, but not inwardly, as yearlings; very few Downs will at that age be sufficiently advanced for slaughtering, from their known disposition to arrive more slowly at maturity." What, then, is wanted is young sheep, large, heavy, and well furnished at a year or fourteen months old, and this object is attained by the cross, as the testimony of the butchers who bought the sheep will show. He continues,—

"You must have observed an immense improvement in the character of the Hampshire sheep generally within the last fifteen or twenty years—an increase of size, a heavier fleece of a longer staple, with a kindlier touch, evidencing a greater aptitude to fatten. I have had my attention called to this fact frequently since I have ceased to be a breeder. How has this altered character

* It is, we believe, generally acknowledged that the Cotswold sheep have been improved by crosses from the Leicester ram; and although the origin of the latter is involved in some obscurity, yet it is generally supposed that Bakewell, the founder, whilst he used the original Leicester or the long-woolled breed, which prevailed mostly in the midland counties, as his foundation, crossed them with various other breeds until he succeeded in establishing the superiority of excellence which he afterwards sought to maintain by pure exclusive breeding.

been obtained? Can we recognise none of the Cotswold fleece or his more symmetrical proportions? And, when I tell you that, in the years 1835-36 and subsequent years, I sold very many half-bred rams, not only into Hampshire Down flocks generally, but into those of six or eight of our first ram-breeders whose names are at this day to be seen upon my books; when you must be aware that these breeders are in the constant annual habit of selling one to another in this and adjoining counties; I trust I may without presumption lay some little claim to having supplied a portion of the material from which our present flockmasters have worked up a better and more valuable fabric."

It is a curious fact that, whilst the system we have detailed has been followed in Hampshire, a very different plan has been adopted in the neighbouring county of Wiltshire. Here the same large, flat-sided, uncouth horned sheep, whose ancestors were its denizens in the days of the Romans, ranged over the Wiltshire Downs, and indeed, retained possession some years later than in Hampshire. They at length succumbed to the superior qualifications of the Sussex Downs which gradually displaced them, not by crossing them out so much as by being substituted in their place, and thus the imported Sussex became the West Country Down. At length a larger sheep and particularly a larger lamb was demanded, and then the Wilstshire breeders procured rams from Hampshire and greatly improved their flocks in size, and secured larger lambs. Beginning with Sussex ewes, they have increased the size of the frame without materially enlarging the heads, and thus a very valuable breed of sheep has been formed, the Wiltshire Down, whose more perfect symmetry frequently enables their owners to wrest the prizes from the Hampshire men, and to cause the latter, by the rivalry thus induced, to improve the symmetry of their sheep by careful selection. The *Wiltshire Down* breeders, therefore, began with the Sussex ewe, and crossed with the Hampshire ram, whilst the Hampshire breeders used the original horned ewe and the Sussex ram. The latter, therefore, have less of the Southdown than the former, and, though of greater size and producing somewhat larger lambs, have less symmetry.

Mr. Rawlence, whom we have before quoted, informs the writer:—

"The original flock from which my present sheep are chiefly descended, was of the Sussex breed and of moderate quality. I commenced by drafting all the small and delicate ewes, and the remainder were crossed with rams of the Hampshire breed. I bred from their produce for two or three years, and then had another cross with the Hampshire, still continuing to cull defective ewes. After I had obtained considerable size from the infusion of the Hampshire blood, I had recourse to some rams bred by Mr. Humphrey of Chaddleworth, Berks, which were the produce of the biggest and strongest Hampshire ewes by a sheep of Mr. Jonas Webb's. I use my own rams, and I also frequently purchase a few of the best Hampshire ewes I can get, put my own sheep to them and use their lambs. I also put a sheep of Mr. Humphrey's to some of the best

of my ewes, and select rams from their produce, thus getting fresh blood without making an entire cross."

Our account of the Hampshire sheep would be by no means complete unless we noticed the sheep of Mr. William Humphrey, of Oak Ash, near Wantage, Berks, specimens from whose flock have so frequently been prize-winners, and their services generally acknowledged by other improvers.

Mr. Humphrey, in a communication to the writer, has furnished the following interesting history of his sheep, which shows that, although they may be correctly designated the Improved Hampshire Downs, they are yet *sui generis* and distinct from any others, and may be considered peculiarly his own:—

"About twenty-five years since, in forming my flock, I purchased the best Hampshire or West-Country Down ewes I could meet with; some of them I obtained from the late Mr. G. Budd, Mr. William Pain, Mr. Digweed, and other eminent breeders, giving 40*s*. when ordinary ewes were making 33*s*. to 34*s*., using the best rams I could get of the same kind until the Oxford show of the Royal Agricultural Society. On examining the different breeds exhibited there I found the Cotswolds were beautiful in form and of great size; and, on making inquiries as to how they were brought to such perfection, I was informed that a Leicester ram was coupled to some of the largest Cotswold ewes, and the most robust of the produce were selected for use. The thought then struck me that my best plan would be to obtain a first-rate Sussex Down sheep to put to my larger Hampshire Down ewe, both being of the short-woolled breed. I thus determined to try and improve the quality and form of my flesh, still retaining the size and hardihood so necessary for our dirty low lands and cold exposed hills. With this object I wrote to Mr. Jonas Webb to send me one of his best sheep, and he sent me a shearling by his favourite sheep Babraham, which made some good stock out of my large ewes. I went down the next two years, and selected for myself; but the stock did not suit my taste so well as the one he sent me, and I did not use them. I then commissioned him to send me his sheep which obtained the first prize at Liverpool; and from these two sheep, the first and the last, by marking the lambs of each tribe as they fall, then coupling them together at the third and fourth generation, my present flock was made. Not having used any other blood on the male side for more than twenty years, I found some difficulty at first, when putting the first-produce ram to the first-produce ewe, the lambs coming too small to suit my customers. To obviate this difficulty I drafted out the finest and smallest-bred ewes, replacing them with the largest Hampshire Down ewes I could meet with that suited my fancy; still continuing to use the most masculine and robust of my rams to keep up my size. Some of my friends advised me to use a large coarse sheep to these small ewes to remedy the defect; but the larger ewe seemed to me the better way, and that course I pursued. I got rid of my smallest ewes and replaced them with large ones, which gave me what I thought to be an advantage—the using no male animal but of my own blood, the pedigree of which I am now acquainted with for more than twenty years. It has succeeded hitherto beyond what I could have expected. My object has been to produce a Down sheep of large size with good quality of flesh, and possessing sufficient strength and hardiness to retain its condition while exposed in rough and bad weather to consume the root-crops on our cold, dirty hills. Independently of the value of the Hamp-

shire or West Country Down in an agricultural point of view for such localities as ours, they produce when slaughtered a valuable carcase of mutton, giving the consumer a good proportion of flesh to the fat, which is a point that may be too much lost sight of. I will, in proof of it, relate an instance which a gentleman told me the other day. When residing in another county he sent to his butcher for 3 lbs. of mutton. The fat seemed so much out of proportion to the lean, that he had the curiosity to weigh the lean. After carefully cutting it out, he found it to weigh ¾ lb., or only one-fourth of the whole. This anecdote indicates to those who are attempting by crosses to establish a new breed, or to improve an old one, the importance of producing an animal in which the flesh forms a due and sufficient proportion of the whole."

In Dorsetshire the same system has been pursued as in Wiltshire, although more recently and to much less extent.

In the eastern part of the county the Wiltshire system of crossing has been followed with still greater latitude. The object being to secure size without coarseness, the rams of the Hampshire as well as the Sussex are each used, as the fancy of the breeder may direct. In one flock, well known to the writer, of very good repute—so much so, that an annual sale of rams and ram-lambs takes place, and for several years past has been very successful—the owner, whose flock was originally Southdown, has increased the size of his sheep by means of the Hampshire ram, but does not hesitate to avail himself of the Sussex from time to time to counteract, as he says, any tendency to sourness, and also uses the choicest of his own breed as well. Here is an evident cross, carried to a considerable extent and with great success, as the high price realized by the sale of fat tegs sufficiently testifies. Other breeders in this county adhere firmly to the Southdown, which they seek to improve by using first-class rams; and the superior quality of their fleece, as compared with the Hampshire, forms no small part of their motives for so doing. Some years since the Southdown sheep in Dorsetshire received a cross from the Devon or Bampton Nott, a large long-woolled sheep, but with a good disposition to fatten. The cross was approved of, and the produce were used by other flock-masters, which circumstance has perhaps rendered the Dorsetshire Southdown somewhat larger than the Sussex.

The *Dorset horned* sheep, so valuable for their early lambs, some fifty or sixty years since reigned supreme over the Dorsetshire Downs. They were then in many instances supplanted by the Sussex, which were found better suited for folding, and were more esteemed for their mutton. Crossing was tried in many instances, but although the half-bred lamb from the Dorset ewe was and still is in great request for early lamb, yet the breeds did not assimilate well; they were as a flock inferior to their parents, and were consequently discontinued; and whilst the Dorset held their own in the west, the Southdown took their place in the eastern

part of the county, and of late years have, in many instances, been crossed by the Hampshire ram.

The Dorset horned sheep is, however, a much superior animal to the old Wiltshire and Hampshire. Shorter on the legs, with a more compact frame and a rounder barrel, this sheep, besides its peculiar value for the production of early lamb and its remarkable prolific qualities, is by no means to be despised for its feeding properties. It is not unusual for these sheep — as well as the kindred though somewhat larger Somersetshire — to be brought into the market in March and April together with their lambs and sometimes pairs of lambs, all fit for the butcher at the same time. The Dorsetshire and Somersetshire sheep are raised on tolerably good land, where they have been preserved pure and improved by selection.* It is usual, however, to put the ewes that are intended to be sold to the Southdown ram, which improves the quality and fatting predisposition of the lamb, and the ewes are usually sold at the Hampshire October fairs, by which time they are very forward in lamb. The buyers of the ewes, although the usual custom is to sell off the ewe and lamb the following spring, sometimes keep a portion of the ewes another year, putting them again to a black-faced ram. It is remarkable that these ewes are not only exceedingly prolific and rarely have any mishap in yeaning their lambs, but will carry on all the functions of maternity whilst almost fat themselves. In South Hampshire, which is celebrated for the excellent quality of its early lamb, this system is carried out to perfection, particularly with the Somersetshire ewe. The drawback to this breed of sheep, as compared with the Hampshire and Southdown, is the longer period required for their maturity, the richer food required, and the somewhat inferior character both of the mutton and the wool.

To return, however, to our proper subject, we may observe that various attempts were made some years since to introduce the merino blood, with the idea that great benefit would be derived from the increased quantity and the superior fineness of the wool; and undoubtedly, if the carcase of the Southdown and the wool of the merino could be united in the same animal, the acmé of sheep-breeding would be attained. It was found, however, that the quality of the wool was not a sufficient recompense for the want of early maturity and feeding properties; and at length, after many trials, the merinos disappeared by the continued use of other rams. It is very possible, however, that they

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* The Dorsetshire flocks have of late years been crossed and improved by the larger Somersets, so that pure flocks of the former are now rare, and the distinction of the two breeds by the colour of the nose has almost disappeared.

may have left behind them some improvement of the fleece, for it is equally difficult in breeding to get rid of a virtue and to wash out a stain. We have confined our examples of cross breeding pretty much to the breeds of our own locality, but it must not be forgotten that other counties have also some noble specimens of cross-bred sheep. Shropshire is celebrated for its breed of sheep, and under the new regulations they compete very successfully at our annual shows. At the Chester meeting they beat the Hampshire Down as old sheep, but in their turn were conquered by the latter in the younger classes. They present themselves to our notice in a more compact form; though shorter, they are wider, broader on the back and deeper through the heart.

This breed was first brought into national repute at the Shrewsbury meeting in 1845, when it was wisely held that it was no longer desirable to confine the honours of the Society to a few particular breeds. The new class "Shortwools not Southdowns," brought into competition with each other, the Hampshire, the Shropshire, and the West Country Down or Wiltshire; and thus, although the labours of the judges were rendered somewhat onerous, yet much good was effected, and the public have greatly appreciated and promoted the various breeds so brought into notice.

The Shropshire originally sprang from a breed called the Morfe Common sheep, and owe most of their great and improved qualities to careful selection. We imagine they would make a very good cross with the Hampshire Down, and might somewhat improve the carcase of the latter, as well as the quantity and quality of wool in the flocks of those breeders who do not attach too much importance to the colour of the face.

The Shropshire speckled-faced sheep is undoubtedly a cross-bred animal, and indeed affords a striking example of the perfection that can be derived by a judicious mixture of various breeds. At a late meeting of a Farmers' Club in this county, Mr. J. Meire observed, "It is not attempted to be denied that the Shropshire is a cross-bred sheep: the original breed was horned, and the first attempt at improvement was to get rid of these incumbrances, and there is little doubt that this was effected by a cross of the Southdown. This sheep was well adapted for the downs, but for the enclosures of Shropshire something more docile was required, consequently, recourse was had to the Leicester." This crossing and recrossing at length gave place to the practice of careful selection, and thus uniformity was sought for and attained, and the present superior breed was established. It is now held that no further cross is required.

The New Oxfordshire sheep is a very valuable breed, originating from a cross between the improved Cotswold and

the Hampshire or West Country Down. Their size being less than the Cotswold, they are better adapted for the ordinary management of a light land farm. This breed is very similar to that first introduced by Mr. Twynam, to which allusion has been made, but probably the Southdown has been used as well as the Hampshire Down.

Although Mr. Twynam may perhaps have a claim to priority in crossing the Hampshire Down ewe with the Cotswold ram, yet from various causes, and probably because the Hampshire hills were scarcely adapted for such large sheep, they failed to establish themselves in this locality; whilst a very few years afterwards a similar experiment was tried in Oxfordshire, and, whether from a milder climate, more fertile pasturage, or other causes, the result was a complete success.

Mr. S. Druce, of Eynsham, Oxon., favours the writer with the following short communication on the subject:—

"The foundation of this class of sheep was begun about the year 1833 (see vol. xiv. p. 211,* of the Journal of the R. A. S. E.), by using a well-made and neat Cotswold ram with Hampshire Down ewes. At the same period several breeders of sheep in this neighbourhood also tried the experiment; consequently there has always been an opportunity of getting fresh blood by selecting sheep which suited different flocks, and thereby maintaining the uniform character which is now established.

"As to the result of this crossing I would refer you to the names of the following, who usually exhibit at the "Smithfield Club" Show, viz.:—Messrs. John Hitchman, Little Milton, Oxon.; William Gillett, Brize Norton, Witney, Oxon.; W. Hobbs, Minsey Hampton, Gloucestershire; A. Edmunds, Longworth, Berks; J. B. Twitchell, Wilby, Northamptonshire; C. Howard, Biddenham, Beds; William Hemming, of Caldecot, near Moreton-in-the-Marsh, Gloucestershire, &c. &c. And amongst ram breeders I would name J. Hitchman, J. Roberts, C. Gillett, W. Gillett, J. Bryan, His Grace the Duke of Marlborough, H. L. Gaskell, Esq., H. Barnett, Esq., all in this neighbourhood, and who offer sheep by auction the second Wednesday in August annually at Oxford."

There are few districts in England in which some advantage has not been derived from the cross breeding of sheep. Even the little *mountain sheep* of Wales has been greatly improved by the *Cheviot* ram, a larger, superior, but still a mountain sheep. At the same time the Cheviots themselves have been improved for the butcher by crosses with the Leicester, the Cotswold, and the Down. The progeny have been increased in size, and fattened more readily. This breed has also been considerably improved by selection.

* In the communication referred to, Mr. Druce gives a table, showing his ideas of the comparative value of the different breeds of sheep, the result of which is in favour of the cross-bred. He adds, "With ordinary skill in sheep-farming, I find no difficulty in keeping the form and size of the animal as it should be; the wool of a valuable quality, and not deficient in quantity; and I maintain that the good qualities can be better secured by employing the cross-bred animals on both sides than by confining the practice to the first cross."

The *black-faced heath* breed, too, so well suited to mountainous districts in which heath abounds, whilst it has been supplanted in certain districts by the Cheviot, has, in other heathy localities, displaced the latter. Although very slow in reaching maturity, the mutton is much esteemed; and the lambs, from a first cross with the Leicester ram, fatten readily when removed to more favourable pasturage than the native habitat of the breed.

The testimony in favour of the advantages to be derived from the cross breeding of sheep when the purpose sought for is limited to the first cross is so strong that, however forcible may be the arguments of the advocates of pure breeding with reference to stock sheep, they sink altogether in weight when sheep for the butcher are concerned. We have noticed the advantageous custom of crossing the Dorset and Somersetshire ewes with the Down ram, thereby improving both the quality and the disposition to fatten of the lambs, whilst the early lambing and nursing qualities of the ewes are equally secured.

In Norfolk an intelligent and experienced correspondent assures us that cross breeding is of the utmost importance to the light land farmers, and that the crosses most esteemed are the Southdown and the Hampshire ewes crossed with the Leicester and the Cotswold ram, by which earlier maturity is secured, together with an increase both of wool and mutton. The cross between two comparatively pure breeds is most esteemed. Most of the graziers in the locality of the writer (Mr. Coleman) speak strongly in favour of the first cross, as possessing both early maturity and a propensity to fatten. The inconvenience of the system is the necessity induced either of selling out every year, or otherwise of keeping up a pure flock, in order to afford materials for crossing. It may be observed that although generally, for the purposes of the butcher, a ram of a large breed is necessary, this is not essential when a permanent improvement is sought for: improved shape and superior quality often follow the ram of a smaller breed. Many owners of sheep, whose flocks were originally cross-bred, declaim very forcibly on the evils of crossing and the necessity of pure breeding.

We cannot do better, in concluding our paper, than gather up and arrange in a collected form the various points of our subject, which appear to be of sufficient importance to be again presented to the attention of our readers. We think, therefore, we are justified in coming to the conclusions:—

1st. That there is a direct pecuniary advantage in judicious cross breeding; that increased size, a disposition to fatten, and early maturity are thereby induced.

2nd. That whilst this may be caused for the most part by the very fact of crossing, yet it is principally due to the superior

influence of the male over the size and external appearance of the offspring; so that it is desirable, for the purposes of the butcher, that the male should be of a larger frame than the female, and should excel in those peculiarities we are desirous of reproducing. Let it be here, however, repeated as an exceptional truth, that though as a rule the male parent influences mostly the size and external form, and the female parent the constitution, general health, and vital powers, yet that the opposite result sometimes takes place.

3rd. Certain peculiarities may be imparted to a breed by a single cross. Thus, the ponies of the New Forest exhibit characteristics of blood, although it is many years since a thorough-bred horse was turned into the forest for the purpose. So, likewise, we observe in the Hampshire sheep the Roman nose and large heads which formed so strong a feature in their maternal ancestors, although successive crosses of the Southdown were employed to change the character of the breed.

It has been asserted by some observers, that when a female breeds successively from several different males, the offspring often bear a strong resemblance to the first male; which is supposed to arise from certain impressions made on the imagination or nervous system of the female. Although this is sometimes or often the case, we doubt very much whether it is so frequent as to be considered as a rule.

4th. Although in the crossing of sheep for the purpose of the butcher, it is generally advisable to use males of a larger breed, provided they possess a disposition to fatten, yet, in such cases, it is of importance that the *pelvis* of the female should be wide and capacious, so that no injury should arise in lambing, in consequence of the increased size of the heads of the lambs. The shape of the ram's head should be studied for the same reason. In crossing, however, for the purpose of establishing a new breed, the size of the male must give way to other more important considerations; although it will still be desirable to use a large female of the breed which we seek to improve. Thus the South-downs have vastly improved the larger Hampshires, and the Leicester the huge Lincolns and the Cotswolds.

5th. Although the benefits are most evident in the first cross, after which, from pairing the cross-bred animals, the defects of one breed or the other, or the incongruities of both, are perpetually breaking out, yet, unless the characteristics and conformation of the two breeds are altogether averse to each other, nature opposes no barrier to their successful admixture; so that, in the course of time, by the aid of selection and careful weeding, it is practicable to establish a new breed altogether. This, in fact, has been the history of our principal breeds. The

Leicester was notoriously a cross of various breeds in the first instance, although the sources which supplied the cross is a secret buried in the "tomb of the Capulets." The Cotswold has been crossed and improved by the Leicester; the Lincoln, and indeed all the long-woolled breed, have been similarly treated. Most of the mountain breeds have received a dash of better blood, and the short-woolled sheep have been also generally so served. The Hampshire and the present Wiltshire Downs have been extensively crossed; the friends of the Shropshire cannot deny the "soft impeachment;" and the old black-faced Norfolks have been pretty well crossed out altogether. The Dorsets and Somersets remain pure as a breed, although they are continually crossed to improve their lambs. The Southdown is perhaps one of the purest breeds we have. No one asserts that the immense improvement of this breed by Ellman was due to any crossing; whether the increased size and further improvement which it has received in other counties have been effected in all cases without a cross of any kind, may be in the minds of some a matter of doubt; yet it is only right to give the arraigned, in the absence of any proof to the contrary, the benefit of such doubt, and consider them still as pure as ever.

We confess that we cannot entirely admit either of the antagonistic doctrines held by the rival advocates of crossing and pure breeding. The public have reason to be grateful to the exertions of either party; and still more have they respectively reason to be grateful to each other. We have seen that Mr. Humphrey cheerfully acknowledges the benefit he derived from Mr. Jonas Webb's rams. Had he grudged the expense of seeking his improvements from such a renowned flock, and been satisfied with inferior rams, he would not have achieved the success which has crowned his exertions. So likewise with the new Oxfordshire breed. What matters it whether the localities occupied by these sheep were divided between their ancestral breeds or occupied as now by their cross-bred descendants: the public is benefited by having better mutton than the Cotswold alone would furnish, and more valuable wool than the Downs could supply; whilst the breeders, finding their account in their balance-sheet, have very properly perpetuated the breed which has paid so well. Our purpose has been to hold the scales fairly between both systems, having no prejudices to serve. Thus, in defending the system of crossing from some of the objections that have been urged against it, we have no wish to be thought forgetful of the merits of a pure breed; on the contrary, we would instance with pleasure the remarkable success that has attended the careful selection which, in the hands of Mr. Merson, of Brinsworthy, near North Molton, Devon, has brought out the

capabilities of the little Exmoor sheep to an amount of excellence which no inspector of the ordinary breed would have believed them capable of attaining. But whilst this instance proves how much can be done by careful selection, vigorous weeding, and pure breeding, and conveys a warning to any rash and heedless practitioner of crossing, yet, if we regard it as a bar against the system, we deprive by anticipation the spirited introducer of this great improvement of the fair reward for his labours which he has a reasonable prospect of obtaining from the proprietors and improvers of other mountain-breeds.

Although the term *mongrel* is probably correct as referring to a mixed breed, yet, as it is generally used as a term of reproach, it should not be fairly applied to those recognised breeds which, however mixed or mongrel might have been their origin, have yet by vigilance and skill become in the course of years almost as marked and vigorous and distinctive as the Anglo-Saxon race itself, whose name we are proud to bear, and whose mixed ancestry no one is anxious to deny.

Let us conclude by repeating the advice that, when equal advantages can be attained by keeping a pure breed of sheep, such pure breed should unquestionably be preferred; and that, although crossing for the purposes of the butcher may be practised with impunity, and even with advantage, yet no one should do so for the purpose of establishing a new breed, unless he has clear and well defined views of the object he seeks to accomplish, and has duly studied the principles on which it can be carried out, and is determined to bestow for the space of half a lifetime his constant and unremitting attention to the discovery and removal of defects.

Eling, Southampton.

XVII.—*Report on the Exhibition and Trial of Implements at the Warwick Meeting.* By Charles Barnett, Senior Steward.

As the Report of the trials of Steam Cultivators, Ploughs, Harrows, Clod-Crushers, Rollers, and other Implements employed in the cultivation of the soil, as well as Miscellaneous Articles, is given at considerable length and with great minuteness by the Judges, it is quite unnecessary for me to make any lengthened observations on those trials. Although the place of meeting at Warwick might not claim all the advantages of the far-famed "Roodee" at Chester, yet it was a site well adapted to the requirements of an Exhibition of the Royal Agricultural Society of England that was numerically in excess of all former meetings, both in imple-

ments and live stock, and would, no doubt, have been so as to visitors, if cheap trains had been run on the Friday from Birmingham and other places, as has usually been the case on former occasions. From my own observation, and the remarks of others, I have every reason to hope that the public were satisfied with the arrangements that were made; and I must here express to my brother Stewards my most sincere thanks for their cordial and indefatigable co-operation, and I am certain they would wish to join their warmest expression of gratitude with mine to the Honorary Director of the Yard, B. T. Brandreth Gibbs, Esq., for his unparalleled exertions, to which the success of the meeting is mainly to be attributed. To the Judges also the best thanks of the Society, and I may also say of the public, are due; and I was gratified to find that the accommodation afforded them gave them facilities in conducting their arduous duties which they fully appreciated. I would here take an opportunity of bearing my testimony to the necessity of carrying out their suggestion of having two permanent paid foremen; one for the yard and one for the field trials. To the Exhibitors also I feel that the thanks of the Stewards are due for their patience and good temper under the most severe trial they ever experienced, in consequence of the hardness, and, in some cases, unevenness of the ground, although I heard one Exhibitor considered *that* an advantage in his case. Some of my agricultural friends may think that my three years' experience as Steward ought to induce me to make some observations as to particular implements, but I do not consider that quite my province, as it might be looked upon as an advertisement; but I will name the great advantage I have experienced during the last year in being in possession of a small 3-horse power steam-engine (my occupation, 200 acres arable and 200 pasture, not being sufficiently extensive to require one of more power): I keep two less horses, and the others in much better condition; no afternoon work, grinding, cutting chaff, &c. &c. I can also, with a small thrashing-machine, at any time, in a few hours, have a journey of corn ready for market. It may be asked, Whose engine do you keep? My advice on that point is, there being several makers of the same fame and respectability, to buy from the one nearest to you, as, in case of repairs being necessary, it is a saving both of time and money. In concluding these few remarks, I must express to Lord Leigh and the Magistrates of the county of Warwick the best thanks of the Stewards for the ample and comfortable accommodation afforded them at the Judges' house, which tended much to lighten their fatigues during the excessively hot weather experienced at this meeting.

Stratton Park, December, 1859.

Report on Steam Cultivation.

There were seven implements selected for competition for the prize of 50*l.* offered by the Society for "the best application of Steam Power to the cultivation of the soil."

Albert Hudson Royds, of Falinge, near Rochdale, entered a set of steam cultivating apparatus, consisting of a portable steam-engine, an improved windlass, self-acting crabs, &c., and a cultivator, invented by the exhibitor, and manufactured by Barnish and Ratcliffe, of Rochdale.

William Henry Nash, of Cubitt Town, Poplar, London, sent a patent steam rotary cultivator, invented and improved by Robert Romaine, of Canada, and manufactured by the exhibitor.

William Crowley and Sons, of Newport Pagnell, entered a set of patent apparatus, invented and manufactured by the exhibitors, consisting of an ordinary 8-horse portable steam-engine, with Hayes' patent windlass, wire-rope, pulleys, and anchors; also a set of universal ploughs.

R. Robey and Co., of Lincoln, entered a steam cultivator, invented by Chandler and Oliver, and manufactured by the exhibitors, consisting of a 10-horse power portable steam-engine, with patent drum-windlass, anchors, &c., and a 3-furrow plough, manufactured by J. and F. Howard, of Bedford.

J. and F. Howard, of Bedford, sent a set of patent apparatus for cultivating land by steam, invented by William Smith, of Woolstone, consisting of an 8-horse power portable steam-engine, with windlass, anchors, wire-ropes, pulleys, &c., and a scarifier with three, and another with five shares or spuds.

J. Fowler, jun., of Cornhill, London, entered two sets of steam cultivating apparatus: the first consisting of a 10-horse engine, with self-moving and reversing gear and windlass, self-acting anchors, wire ropes, snatch-blocks, &c.; also a balance 4-furrow plough, fitted with scarifier irons, and a balance 3-furrow Cotgreave plough.

The other set consists of an 8-horse power engine, with apparatus on the same principle as the above, and a balance 3-furrow plough or scarifier.

The trials commenced on the 8th of July, in a field of two-year old ley, the soil a very stiff loam, which resisted the action of the implements as much as any land we had ever witnessed, owing to the extreme heat and long-continued dry weather; and it was, in the true sense of the word, a *trial field.*

It soon became evident that the ground was too hard for Royds' cultivator, which works with 9 coulters, 3 one way and 6 the contrary way, the 6 coulters returning over the same ground which the 3 have partially broken up. It was regulated and steered by a man walking behind, who did not seem to have sufficient command of the implements; and it was only by the most indefatigable exertions that he succeeded in going a few rounds with it.

Nash's rotary cultivator, invented by Robert Romaine, from various causes, chiefly connected with the faulty state of the engine, was also unable to proceed, and we have to regret that we had not a better opportunity of testing this implement, which, in many respects, deserves commendation. The way in which it lifts the digger out of the ground, and the ease with which it turns round on its own length, are admirable arrangements.

The set of steam cultivating apparatus by Crowley and Sons, after several attempts, was also obliged to retire. It is worked by a stationary engine, with windlass, wire ropes, anchors, &c., the chief feature being the windlass, which throws the work out of gear, rendering it unnecessary to stop the engine at any time during the work.

The trial was now confined to three competitors—Messrs. Robey, Howard, and Fowler (2 sets); and a second field having been provided, they commenced the final trial on Monday, the 11th of July, in a field near the other, but, instead of being level, like the first, it was hilly, and the soil of a stronger nature. The ground being equally apportioned, they each started to work at a given time.

Robey's cultivator, manufactured by J. and F. Howard, consists of a 3-furrow plough, driven by a stationary engine, with windlass, &c., and works on the triangular system. The plough consists of a strong iron frame, with three sets of coulters, mould-boards, &c., arranged on one end, and three on the other contrariwise, the one being raised and the other lowered by means of a joint at the middle of the frame. This implement was not sufficiently substantial for the hard ground. It was also with difficulty kept in the work with two or three men riding on it. The quantity of work done was at the rate of 45 perches per hour, requiring 9-horse power. The time required for changing position was 25 minutes.

The steam cultivator exhibited by J. and F. Howard, and invented by Smith of Woolstone, is too well known to need any description here as to its working arrangements; but during the years it has been in use it perhaps was never more severely tested than at Warwick. This system requires two operations: the first with a cultivator having three strong wrought-iron shares, taking a breadth of 26 inches, and the second with one of larger dimensions, fitted with five shares, taking a breadth of 48 inches, and worked at the same depth as the other, but in a transverse direction, thereby removing the whole of the soil to a given depth, and leaving the surface in a rough state, well suited for autumnal cultivation. The draught of this implement was irregular, and we noticed a jerking, caused probably by the very hard state of the land. The quantity of work done by this cultivator was at the rate of 114 perches per hour, for *only one* operation, requiring $11\frac{3}{4}$-horse power. The time required for changing position was 30 minutes.

Lastly, we come to Fowler's well-known system of steam cultivation; and we may here mention that considerable improvements have been carried out since last year in simplifying the various parts of the apparatus, by which the loss of power from friction has been diminished, and consequently a considerable saving in the wear and tear effected; and another feature is the simple and very easy mode of changing the plough into a cultivator, by putting on peculiarly constructed shares and mould-boards, thereby retaining all the *steady* cutting properties of the plough, while the cultivator breaks up the land in beautiful style, and leaves it in a thoroughly rough and irregular state for the action of the atmosphere. The work done by the 4-furrow plough or cultivator was at the rate of 105 perches per hour, requiring $11\frac{1}{2}$-horse power. The time required to change position was 57 minutes.

The Cotgreave plough was also tried with the same apparatus, and made very good work.

Fowler's 3-furrow plough or cultivator is worked by an engine of less power but on the same principle as the 4-furrow plough: this is a very good implement, making a complete fallow of the hardest land at one operation. The quantity of work done was at the rate of 100 perches per hour, requiring $7\frac{3}{4}$-horse power.

The comparative trials of the four last-mentioned cultivators will stand thus:—

	Quantity of Work per Hour.			Horse-power used.	Time required to change Position.	Price of Engine, Apparatus, and Cultivator complete.		
	A.	R.	P.		Minutes.	£.	s.	d.
Robey and Co.	0	1	5	9	25	460	0	0
Howard (Smith's patent)	0	2	34	$11\frac{3}{4}$	30	555	0	0
Fowler's Four-furrow	0	2	25	$11\frac{1}{2}$	57	703	0	0
Fowler's Three-furrow	0	2	20	$7\frac{3}{4}$	57	589	0	0

These trials having been intrusted to our decision by the Council of the Royal Agricultural Society, and carefully conducted under our immediate superintendence, we are unanimously of opinion that Fowler's apparatus is "the best application of steam power to the cultivation of the land," and we consider him entitled to the Prize of 50*l.*, and therefore make our award accordingly.

We also *highly commend* Fowler's 3-furrow plough or scarifier: and we *commend* Howard and Smith's cultivator as a very useful implement, well suited for autumnal cultivation.

William Owen.
Joseph Druce.
John Thompson.

Report of J. J. Rowley *and* John Brasnett, *the Judges appointed by the Stewards to test the merits of Ploughs, and award the Society's Premiums for this Class of Implements.*

During our inspection of the great number of ploughs in the show-yard, we found 47 whose owners were anxious to contend for the premiums offered by the Society. Of these 15 were intended for light land, 9 for heavy land, and 13 were ploughs for general purposes, and adapted for both heavy and light soils. Besides these, 3 were turnwrests, and 7 were ridge-ploughs.

The trial on both heavy and light land was most severe. The ground selected had been much trodden during pasturage, and the surface having been exposed to a scorching sun and dry arid winds, rendered the trials extremely difficult to conduct. The masterly style in which the work was done called forth expressions of surprise, and convinced all who witnessed the trials that nothing but iron ploughs could have found their way through such a hardened soil. The superiority of the wheel over the swing-plough was never more clearly demonstrated than on this occasion, and the most sceptical could not fail to be convinced that the trial at Warwick gave sufficient evidence of the advantages possessed by the wheel over the swing-plough.

Before making any comment on the various trials, we feel it our duty to state that the land was so completely unprepared for the working of the ridge-plough, that no satisfactory result could be arrived at. Under these circumstances the Judges were reluctantly compelled to make no award on a class of implements which, in root cultivation, are of the greatest importance. We would suggest that the future trials of this class of implements should take place upon a stubble fallow which has been prepared for turnips in the ordinary way.

The first trials coming under our care were the light-land ploughs. Of these, the contest lay between the exhibitors named in the following schedule; and we take the present opportunity of thanking them and the competitors in other classes for their patience and perseverance under difficulties of no ordinary kind. The trial, as before stated, was severe, but equally so for all; the land being uniformly hard, with a slight difference only in its natural texture. All these differences, where they did exist, were taken into consideration, and the general instructions given to ourselves by the Council have had due weight and influence in guiding us to the decisions at which we arrived after a protracted trial under a dog-day sun. Our examinations into the manufacturing details of these important implements were very satisfactory, and, guided by the mechanical skill of Mr. Amos, the Society's engineer, led to inquiry and explanation, showing how much time had been given to their manufacture, and how much studied care and intelligence had been brought to bear to perfect the plans and different arrangements found in every plough brought

forward for trial. In concluding our Report on light-land ploughs, we can only say that those ploughs which apparently are offered at the lowest price are not the cheapest, while those which are advertised at the most money have some advantages of construction and build not seen or appreciated by the agriculturist generally. The power to move the ploughshare horizontally and laterally is of some importance to the ploughman, especially when it is nearly worn out. The value of the chill, and hardening those parts of the share exposed to the greatest wear and tear, cannot be over-estimated; and we beg respectfully to call the attention of moulders and implement-makers to the necessity of paying attention to this valuable process. We mention this because it was found in the course of several examinations that the hardening had not been sufficiently attended to.

LIGHT-LAND PLOUGHS.

Stand	Art.	Exhibitor's Name.	Time.		Traction.	Yards.	Price.			Premium Awarded.
			M.	S.			£.	s.	d.	£. s. d.
142	3	Busby ..	3	2	135·	175	4	4	0	Highly commended.
66	2	Hornsby ..	3	15	139·76	175	4	17	0	4 0 0
95	1	Reeves ..	3	12	120·625	175	4	16	6	..
98	3	Tasker ..	3	30	136·54	175	5	8	6	..
99	20	Wallis and Haslam ..	3	17	129·9	175	3	18	6	..
106	3	Bruce ..	3	10	132·95	175	4	15	0	..
117	4	Goulding	3	2	136·75	175	5	0	0	Commended.
129	7	Page	2	40	132·95	175	4	0	0	Highly commended.
139	2	Ball	3	2	142·	175	4	14	6	Ditto.
159	11	Hensman	2	30	142·3	175	4	4	0	1 0 0
176	3	Ransomes & Sims ..	2	50	136·	175	4	19	0	3 0 0
188	3	Howards	2	40	138·46	175	4	17	6	2 0 0
125	9	Maggs ..	2	35	134·55	175	4	17	6	..

TURNWREST PLOUGHS.

Stand.	Article.	Exhibitor's Name.	Premium.
			£. s. d.
152	4	Eddy	2 0 0
176	8	Ransomes and Sims	Highly commended.

The use of these ploughs is confined, or nearly so, to the deep soils and undulating districts of the county of Devon. To be continually ploughing the soil down-hill appears a practical error, which, in time, must materially injure the upper parts of the field, without any corresponding advantages to the lower.*

* The Devonshire hill-farmers are quite alive to the importance of turning the furrow up-hill wherever it is practicable, and this is not unfrequently done by a good turnwrest plough, even where the gradient is so steep as to rise one foot in three.—T. D. ACLAND.

GENERAL-PURPOSE PLOUGHS.

Stand	Art.	Exhibitor's Name.	Yards.	Time.		Traction.	Price.			Premium Awarded.		
				M.	S.		£.	s.	d.	£.	s.	d.
39	2	Hitherley	80	1	40	123·9	5	2	6		..	
66	1	Hornsby & Sons ..	80	1	45	120·2	5	0	6	5	0	0
98	1	Tasker & Sons ..	80	1	30	123·59	5	9	6		..	
117	5	Goulding ..	80	1	25	127·05	5	5	0		..	
129	5	Page	80	1	10	119·15	5	0	0		..	
139	1	Ball	80	1	12	115·9	4	14	6	Highly commended.		
142	2	Busby ..	80	1	20	117·1	4	17	6	2	0	0
152	2	Eddy	80	1	28	118·95	3	15	0		..	
159	9	Hensman ..	80	1	8	112·63	5	6	0	1	0	0
176	4	Ransomes & Sims ..	80	1	56	117·85	5	4	6	4	0	0
188	1	Howard ..	80	1	35	123·35	5	0	6	6	0	0

HEAVY-LAND PLOUGHS.

Stand	Art.	Exhibitor's Name.	Yards.	Time.		Traction.	Price.			Premium Awarded.		
				M.	S.		£.	s.	d.	£.	s.	d.
188	15	Howard ..	50	1	14	132·25	6	16	6	2	0	0
176	5	Ransomes & Sims ..	50	0	45	138·475	7	14	6	2	0	0
66	9	Hornsby & Sons ..	50		..	132·38	6	12	6	3	0	0
139	3	Ball	50	0	50	127·33	5	17	0	1	10	0
142	1	Busby ..	50	0	50	137·0	5	17	6	1	10	0

The condition of the heavy land was (if possible) harder and worse for the trial than the light land. But the ploughs intended for this description of soil did their work in an admirable manner; turning up, with the power of four horses, a furrow 12 inches by 9, the subsoil of which had not been moved at any antecedent period. The occupier of the field expressed his astonishment, and lookers-on were surprised, at the severe yet uniform nature of the work so gallantly performed by the heavy-land ploughs. There were some breakages, as might be expected, considering the traction required, but they were of trivial importance, and did not affect the strong beams and bodies of the ploughs under trial, not one of these having given way.

The general-purpose ploughs (perhaps the most useful under trial) stood the heavy land traction with good effect, and firmly met the resistance offered —not giving way or yielding to the heavy pressure upon them.

It may not be out of place to inquire of plough-makers how far convexity of the shelboard (turn-furrow) is desirable? Perhaps a little may be useful; but inasmuch as the convex part, receiving the most pressure, would sooner wear away, some limit will have to be observed. Very likely it would assist in cleaning and polishing new ploughs.

Snowden's (late Woofe) plough, having been placed in the miscellaneous department as a new instrument, did not come on for trial. It is constructed on the principle of reducing the friction and draught by introducing a wheel to carry the plough and remove the pressure from the slade (plough bottom). The prin-

ciple appears to be new to the plough, and may be of some service. At the same time it seems difficult to introduce any improvement either in the principle or construction of ploughs as they are now manufactured.

J. Jephson Rowley.
John Brasnett.

Trial of Harrows for Light and Heavy Land, Cultivators for Light and Heavy Land, Clod-crushers, and Plain Rollers.

The division of implements assigned to us for trial consisted of those made use of in the preparation of the soil for seed of different kinds; comprising harrows for light and heavy land, cultivators for light and heavy land, clod-crushers of various constructions, and plain rollers. The only articles that we tested with the dynamometer were the best cultivators on the light land, as we found on testing the cultivators on the heavy land that the dynamometer got strained, and consequently would not register, so that we were obliged to decide on the merits of the implements according to our own judgment. We may observe, however, that in every trial "quality of work," as well as quantity, was our chief consideration; without which, the other elements of excellence, such as construction, power, time, &c., were not taken as valid claims for the prizes.

Cultivators for Light Land.

Seventeen implements were selected in this class for trial: one was withdrawn, and one refused to compete; the others were all tried—first, with broad shares upon a piece of pastured seeds as paring-ploughs, and though the ground was dry and hard, and in a state more unfavourable than any farmer would select for the use of such implements, the páring done by some of them was very good work; the best test was with the broad share, as they all worked well with points; but our object was to get a simple and good implement that would do both operations well, and, having tried them all, we tested the four best with broad shares with the dynamometer, and the result was, after calculating the width, depth, and power consumed in draught, that we awarded a prize of 5*l.* to Mr. Bentall, 3*l.* to Messrs. Coleman and Son, 2*l.* to Mr. Clay, and commended Mr. Carson's. We also awarded a Silver Medal to Mr. Snowden for Woofe's Paring Plough, which worked well, cutting every particle as perfectly as possible not more than an inch deep.

Cultivators for Heavy Land.

Fifteen implements were selected in this class, but nine only were tried; the other exhibitors were not present to try their implements. The result of the trials proved different on this land; although it was heavy land, it was in a better state and more proper for such implements, having only a few days previous been cleared of a crop of peas; the implements all being nearly the same as were tried on the light land. We awarded 5*l.* to Messrs. Coleman and Son, 3*l.* to Mr. Bentall, and 2*l.* to Messrs. Ransomes and Sims. Mr. Clay having gone to work with a broken share, his implement soon failed to work. Messrs. Mapplebeck and Lowe tried one of their make on Coleman's principle, but one tine soon gave way, and the implement turned upside down.

Harrows for Light Land.

Twenty-eight sets were selected for trial in this class, but sixteen only were tried, on some land that had been previously ploughed, and which was a very good test. Some of them made very indifferent work; in fact, it would

be impossible for a greater difference to be shown in the work done. We awarded 4*l*. to Messrs. Howard, 3*l*. to Messrs. Howard, 2*l*. to Messrs. Page and Co., highly commended those exhibited by Messrs. Ransomes and Sims, and commended those tried by Mr. Comins.

Chain Harrows.

Five sets were selected for trial, and all were tried, except Mr. Busby's, who was not present to explain or try his; they were of an entirely new construction, the corners of the squares having points about 2 inches long. We awarded 2*l*. to Messrs. Mapplebeck and Lowe, highly commended Mr. Cartwright's, and commended Mr. Cambridge's.

Harrows for Heavy Land.

Eleven sets were selected and tried in this class, and we awarded the prizes as follows:—4*l*. to Messrs. Howard, 3*l*. to Messrs. Page and Co., 2*l*. to Messrs. Ransomes and Sims, highly commended Mr. Bentall's, and commended those tried by Messrs. Page and Co.

Plain Rollers.

Twenty-one were selected and twelve of them were tried, the other exhibitors being absent or refusing to allow their rollers to compete. The improvements in the construction of several of them was well deserving notice, and we awarded the first prize of 5*l*. to the trustees of William Crosskill, 3*l*. to Messrs. Hill and Smith, 2*l*. to Messrs. Hill and Smith, highly commended one tried by Messrs. Holmes and Son, and commended one tried by Messrs. Woods and Son.

Clod-crushers.

Twenty-two were selected, and twenty-one of them were tried. Some valuable improvements were made in some of them; but the land prepared for the trial being so extremely hard and dry, the impression made by some of them was very little. We awarded 5*l*. to Messrs. A. and E. Crosskill, 3*l*. to Mr. William Cambridge, 2*l*. to the trustees of William Crosskill, highly commended Mr. Cartwright's, and commended Messrs. Coleman and Son's, the one tried by them having a rising joint in the centre.

In closing our Report we beg to suggest to the Council the importance of having two permanent foremen, one for the yard and one for the field, as they would greatly accelerate the Judges in their respective departments.

Cultivators for Light Land.

Number of Implements tried.	Amount of Prizes.	Number of Article on Prize-sheet.	Exhibitor's Name.
	£.		
15	5	4	Mr. Bentall.
	3	4	Mr. Coleman.
	2	4	Mr. Clay.
	Commended	4	Mr. Carson.
	Silver Medal	..	Mr. Snowden, for Woofe's Paring-Plough.

CULTIVATORS FOR HEAVY LAND.

Number of Implements tried.	Amount of Prizes.	Number of Article on Prize-sheet.	Exhibitor's Name.
	£.		
9	5	4	Mr. Coleman.
	3	4	Mr. Bentall.
	2	4	Messrs. Ransomes and Sims.

HARROWS FOR LIGHT LAND.

32	4	3	Messrs. Howard.
	3	3	Ditto.
	2	3	Messrs. Page and Co.
	Highly commended	..	Messrs. Ransomes and Sims.
	Commended	..	Mr. Comins.

CHAIN-HARROWS.

	2	3	Messrs. Mapplebeck and Lowe.
	Highly commended	..	Mr. Cartwright.
	Commended	..	Mr. Cambridge.

HARROWS FOR HEAVY LAND.

	4	3	Messrs. Howard.
	3	3	Messrs. Page and Co.
	2	3	Messrs. Ransomes and Sims.
	Highly commended	..	Mr. Bentall.
	Commended	..	Messrs. Page and Co.

PLAIN ROLLERS.

12	5	5	Trustees of W. Crosskill.
	3	5	Messrs. Hill and Smith.
	2	5	Ditto.
	Highly commended	5	Messrs. Holmes and Son.
	Commended	5	Messrs. Woods and Son.

CLOD-CRUSHERS.

21	5	6	Messrs. A. and E. Crosskill.
	3	6	Mr. Cambridge.
	2	6	Trustees of W. Crosskill.
	Highly commended	6	Mr. Cartwright.
	Commended	6	Messrs. Coleman and Son.

JOHN HICKEN, Bourton-on-Dunsmore, near Rugby.
GEO. M. HIPWELL, Cheam, Surrey.

Miscellaneous Department.

It is not often that the Judges of this department have much of importance to report upon, and the exhibition of this year is, with but few exceptions, a repetition of that of former years. The first thing that struck us was the immensity of the show. It appeared so large as to cause some anxiety lest we should not be able to pass over it consecutively, and do justice to its numerous claims to our attention, extending as it did to between 4000 and 5000 implements and other articles requiring our inspection. As some excuse for any omission which might be apparent in our course round the yard, we may say, that, had we allowed but one minute's time to the examination of each article, it would have fully occupied us for at least nine days. We had to complete the whole in four, besides the field-trials. Another cause of perplexity was the true definition of an agricultural implement or machine; for such is the variety and complexity of the exhibition, as now extended, that almost all conceivable articles used by parties occupied in agricultural pursuits are entered for examination, from a beef-steak beater to a baby's cradle or cot. We select a few alphabetically, and we ask what special connexion such machines have with agriculture, viz., apple-parers, alarum-bells, bedsteads, bread-machines, beer-engines, bells, counting-machines, cages, deed-boxes, filters, gun-covers, game-bags, hammers (atmospheric), knife-cleaners, machines for aiding digestion, microscopes, odometers, perambulators, roasting-jacks, sewing-machines, sign-paintings, trunks, thermometers, urns, varnish, whisks, window-frames, &c. We had pleasure in their inspection, but we were very cautious in our awards, and endeavoured to confine them to their legitimate object,—the improvement of agricultural implements and machinery. We would further say that, as the exhibition is becoming such a very extensive and important one, we would rather encourage than object to these multifarious collections, and at once make it what, in fact, it is, a large and most interesting mart for the exhibition and sale of useful articles in great variety; but we would urge that the Society's funds should be wholly confined to those connected with agriculture, though found in the miscellaneous department. In pursuing our examination we found, as usual, many novel inventions, most of them more novel than useful, and as such we were compelled to leave them unnoticed. We look upon the office of a Judge to be more that of a guide to the public mind than merely to award prizes, &c. Hence we were more liberal in our commendations to established and useful implements and machinery, and wary with unusual novelties, many of which are sent to be tried for the first time, and to meet the approval or condemnation of the Judges, no enviable position for them. Having much before us, we took the stands as per catalogue, in which order we will take them in this Report, reserving those implements for more especial notice, which are included in the prize classes, and omitting those which have a periodical trial. At Stand 1, B. Fowler's, we gave commendation to a pump having a foot-piece valve at the side, with a door, so as to give ready access to be cleaned. At Stand 5 we found an ingenious machine, invented by W. A. Mann, Esq., for destroying caterpillars, fly, &c., upon turnips, the most commendable part being the revolving brushes, taking two rows, followed by ordinary curved hoes, and a small roller, for the application of it: we gave it a commendation. To Robert Maynard, Stand 18, we gave a commendation for his dibbling machine. The peculiarity is that, as the wheel revolves, provision is made to clear the hole by a twist of each dibble on leaving the soil, thus producing a clean hole for the seed. To A. and E. Crosskill we gave a commendation for their improved liquid-manure cart, the improvement being chiefly in the valve and lever. To S. and E. Ransome we awarded a commendation for their improved argand fire-bars. The air passing through the

fire-bars gives such a well-regulated supply as to produce an almost perfect system of combustion. To Stand 40, Thomas Perry and Son, we awarded a commendation for their extensive exhibition of iron gates, fencing, hurdles, and many very useful articles of like character. To Stand 46, the trustees of W. Crosskill, we had the pleasure to award a commendation for a very superior show of waggons, carts, wheels, &c. To Stand 61, Benjamin Keel, we gave with much gratification a commendation for several specimens of most excellent workmanship in cooperage, consisting of churns, tubs, buckets, &c. To Stand 65, Peyton and Clark, we awarded a commendation for their capital assortment of tools, amounting to 200 bundles, in very useful and extensive variety (we don't include these 1001 tools as part of the 5000, except as named *bundles*). To Stand 72, the St. Pancras Iron-Work Company, we also awarded a commendation for their stable fittings and general collection. These were very superior. To Stand 77 we also awarded a commendation for their large show of machines, engines, and other very useful implements. To Stand 81, William Roberts, we awarded a commendation for a beautiful display of ornamental gates, chairs, and other interesting articles. In Stand 82 we found a Flavel's kitchen-range, of extraordinary capacity and usefulness, fitted up in splendid order, to which we awarded a silver medal. In Stand 87, Holmes and Son, we found a very superior portable saw-bench, with self-acting feed motion of very simple and effective character. We gave to this a high commendation. At Stand 122, Thomas Johnson and Co., we found a very superior collection of wire-netting, weighing-machines, garden-chairs, vases, stoves, &c., for which we gave a commendation. To Stand 128, Hill and Smith, we also awarded a commendation for a very large collection of useful articles and implements, but more particularly for their gates and fencing. In Stand 138, James Woods and Co., we were pleased with a most compact and ornamental cabinet mangle, to which we with great pleasure awarded a commendation. At Stand 205, Priest and Woolnough, we found Rowley's turnip-duster and fly-destroyer, to which we gave a commendation. In Stand 209, John Warner and Sons, we found a splendid collection of hydraulic machinery, to which we had great pleasure to award our commendation. To Stand 233, Thomas Gibbs and Co., we had great pleasure in awarding the Society's Silver Medal, for a most splendid and beautiful collection of dried specimens of permanent grasses, English wheats, barleys, oats, &c. &c., in the ear; also of foreign wheat, barley, oats, &c., in the ear; also samples of grass-seeds, agricultural seeds, and specimens of roots in great variety. To Stand 237, Peter Lawson and Son, we also had great pleasure in awarding the Society's Silver Medal, for a splendid collection, consisting of the most important varieties of grain in the straw and sheaf; also of all kinds of forage-plants cultivated in the United Kingdom, models in wax of mangolds, carrots, turnips, &c., and a beautiful show of hardy coniferous and other trees; also small garden implements. To Stand 240, H. Bridges, we with great pleasure awarded a high commendation for his exceedingly well executed and large variety of butter-prints, &c. To Stand 230, Francis Morton, we awarded a commendation for his improved wire-strainer and fencing apparatus. To Messrs. W. H. and G. Dawes, Stand 229, we also with much pleasure awarded the Society's Silver Medal for their atmospheric hammer, a very effective and powerful implement. The blow given by atmospheric pressure can be increased or diminished as required: the vacuum is managed in a very simple manner, and a blow equal to one ton in weight can be given very rapidly. It is driven by a 4-horse steam-engine. The classes coming more immediately under our adjudication for the various prizes were brick and tile-making machines, draining-ploughs, farm-gates, draining-pipes, and draining tools. Our most important trial consisted of the brick, and brick and tile machines, one of which, exhibited by Mr. H. Chamberlain, of Kempsey, near Worcester,

attracted great attention, and was, in fact, the most attractive machine in the show-yard. It professes to take clay (dry and hard) from the hillside, or elsewhere, and without a drop of water to make it into a good hard brick, ready for the burning; and this it effected in a very surprising manner. It is not important that the clay should be pure, for by its process of grinding it converts gravel and small stones into like powder with the clay. It also makes good bricks from raw silica. All this is done by the expulsion of the air causing it to cohere by a powerful upward pressure. The flying dust of one moment is a dry solid brick the next, and so hard that, for inside work, it need not necessarily be burnt. We should observe that dry clay, in its natural state, holds from 15 to 25 per cent. of water, which only great heat can abstract. This aids the close adhesion. Bricks thus made are unusually heavy, weighing about eleven pounds, and burning to about nine pounds. They are admirably fitted for the internal work of sewers and foundations for great buildings, as well as the whole structure. The machine is a compound one; the mill for grinding, and the moulder for the making. The mill is a common crushing mill, with heavy revolving rollers on a table or circular platform, around which are gratings, through which the dust passes into an iron pan beneath, from whence it is by elevators raised to the hoppers above the machine, to descend through a spout into the moulds for the pressing. This is done as follows: motion being communicated, the tappet-wheel turns the mould-table the length of one mould: this circular table contains sixteen moulds, and revolves at an equable moderate pace. This action delivers two empty moulds under the hopper to receive the clay-dust, delivers two bricks to the attendant, and gives a powerful upward pressure to the clay. The table is then momentarily stationary, while the two excentrics prepare and deposit the charge for two bricks, the tappet-wheel again turns the table, and thus the making proceeds. The whole motions of the machine are performed by a pair of cam-wheels, other pressure being communicated by a pair of rollers running in the cams, with the mould-pistons fixed on a shaft between them. It will thus make twenty-four bricks per minute, and driven by a 6-horse power engine it is capable of giving a pressure of 330 tons upon each brick, which can be increased according to the power of the engine. The ordinary pressure is about 40 tons, depending upon the quality of the clay. The machine itself weighs about 22 tons. We had the benefit of the assistance and the advice of most of our colleagues relative to the utility and novelty of the application of this process in the manfacture of bricks for general use, and the result was the unanimous award of the Society's Silver Medal. This machine is patented by Messrs. Hervey and Walsh, of Wakefield. Mr. Chamberlain also exhibits two other machines: one (invented by Messrs. Bradley and Craven) for the manufacture of bricks from plastic clay upon a somewhat similar principle, *i.e.* a revolving table with moulds. The operations of pugging, moulding, and delivering proceed simultaneously. This machine delivered beautifully made bricks from the plastic clay at the rate of 35 per minute, the moulding and pressing being similar to the large machine. We also awarded to it the Silver Medal. The machine which received the second prize was invented by Messrs. Wright and Green, Rugby. This forces through the face a clear beautiful column of clay, from which it cuts by its revolving wire from a kind of web about 50 bricks per minute, and pipes or tiles after the same proportion. Mr. Whitehead, of Preston, exhibited several excellent machines in this class. His steam machine is a very effective one, and manufactures beautiful bricks with great exactness and rapidity, and tiles or pipes in the same ratio. The clay has to be well prepared, and then the daily produce may reach to from 15,000 to 20,000 bricks. We awarded to it the prize of 10*l.* His smaller machine appears to require much preparation of the clay before screening. When this is done it makes excellent bricks or pipes. We awarded it a commendation. His hand tile-machine is exceedingly good, and worthy the second prize, which we gave it.

Mr. Scragg, Calvely, exhibited a very superior hand-power machine, well known to the public. It screens admirably, and makes rapidly. We had great pleasure in awarding to it the first prize. In the class of draining tools, in the several stands we inspected, we found nothing more than those of a common order. We gave the first prize to those exhibited by Francis Parkes and Co., and a second prize to Messrs. Mapplebeck and Lowe. In the class of draining-pipes we found some useful pipes, plain and good. Messrs. Loomes and Co., Whittlesea, showed very serviceable sets of strong pipes made of durable well burnt clay. To these we awarded the local prize of 10*l.* Mr. Robinson, Nuneaton, showed some good sets of pipes, to which we awarded a commendation. Mr. Scragg also showed some excellent pipes, which we commended.

One of the most important implements coming into our department was the steam draining-plough exhibited by Messrs. A. and W. Eddington, Chelmsford. This is, with very slight alteration, the same implement which effected such suprising work at the Lincoln Meeting, and the real pioneer of steam-cultivation as now achieved. It works most efficiently not only in depositing a series of pipes by means of its singularly strung rope, but effects a stirring of the soil for several feet on each side of the machine as it passes along, thus opening up crevices for the percolation of the water to the drains. We had great pleasure in awarding it the prize of 15*l.*

The whole show of implements, taken collectively, was unquestionably the largest and finest the Society has yet had, and added greatly to the interest of the meeting. It was almost impossible to do justice to it; but in justice to ourselves we must say that we spared neither pains nor trouble to fulfil our duties; the extent was beyond our powers. The whole of the Judges wish to express their thanks to the Council and the local authorities for the comfortable quarters provided for them during their stay at Warwick.

W. Tindall.
John Clarke.

XVIII.—*Report on the Exhibition of Live-Stock at Warwick.* By Robert Smith.

The progress of agriculture was well exemplified at the Warwick Meeting. On entering the show-yard you could not fail to be impressed with the growing importance of modern agricultural machinery. Evidence of this accumulated at every step as you walked by the stands of our numerous implement makers, until at length the eye was relieved by the more natural occupants of the live-stock department. Here, as much as in the shedding previously traversed, was to be seen the result of observation, thought, and enterprise. Long lines of animals of the several orders set forth the produce of England's varied soils and climate. It was a gathering not of British animals alone, but of all that relates to the wealth of agriculture.

The mechanic and the breeder meet here on common ground; the results of their skill undergo a common trial, and receive such a meed of praise as they respectively deserve. Implements are tested, animals compared, and men's minds rubbed and polished by the intercourse arising from such meetings.

In drawing up a Report of the Chester Meeting, it became my province to review the annals of the Society's progress over its

past period of twenty years. That progress had not only shown itself in remodelling the established breeds, but in fostering new ones. To illustrate these improvements I then glanced at the history of the English breeds and breeders. This done, it now remains for me to place on record the result of the Society's succeeding gathering at Warwick. The following is an enumeration of the several classes of animals exhibited on this occasion:—

CATTLE.

	Bulls exceeding 2, and not exceeding 4 years old.	Bulls exceeding 1, and not exceeding 2 years old.	Bull Calves.	Cows in Milk or in Calf.	Heifers in Milk or in Calf.	Yearling Heifers.	Total.
Short Horns ..	34	33	33	48	30	41	219
Herefords	11	21	16	19	10	17	94
Devons	9	9	6	5	7	9	45
Other Breeds ..	12	6	..	22	5	8	53

HORSES.

Agricultural Stallions of any Age.	Agricultural Stallions, 2 years old.	Thoroughbred Stallions.	Dray Stallions, any Age.	Dray Stallions, 2 years old.	Stallion Ponies.	Agricultural Mares and Foals.	Agricultural Fillies.	Agricultural Mares, Fillies, or Geldings.	Hunting Mares or Geldings.	Dray Mare and Foal.	Dray Fillies.	Mares for Breeding Hunters with Foal.	Mares for Breeding Hackneys.	Total.
39	18	11	18	6	10	20	13	17	24	6	3	15	12	212

SHEEP.

	Shearling Rams.	Rams of any other Age.	Shearling Ewes.	Total.
Leicesters	36	47	30	133
South Downs ..	34	15	50	99
Long Wools ..	44	19	50	113
Short Wools ..	113	49	190	352

PIGS.

Boars of a Large Breed.	Boars of a Small Breed.	Sows of a Large Breed.	Sows of a Small Breed.	Breeding Sow Pigs of a large Breed.	Breeding Sow Pigs of a small Breed.	Total.
27	19	32	47	57	54	236

NOTE.—For Tabulated Statements of preceding Shows see 'Chester Report,' vol. xix., p. 354.

Of the Warwick show it may be summarily said, that its results even surpassed in importance those of the Chester meeting. Of either, however, it may yet be said by the stranger visiting these displays of our produce, "What means this diversity of colour and character in the varied cattle classes? this dissimilarity of sheep? this inequality of size in swine? this varying character in horses?" Let us reply, "Animals of different size and quality are required for the varied purposes of our agriculture." It may, however, then be asked, "What are the distinctive properties and uses of Short-horns, Herefords, and Devons? what of long or short woolled sheep? of large or small breed pigs? and what are the points of excellence that guide the Judges in making their award?" These questions open up important ground for consideration when reviewing the "Established Breeds" as they occur in the Society's programme.

Established Breeds of Cattle.

Short-horns.—The term "short-horn" formerly embraced every denomination of the race, from the commonest mongrel up to the cultivated animal. The common short-horn was by nature an animal of low standing, of coarse quality, requiring a good climate, a generous soil, and liberal treatment. These were reared for the uses of the dairy, and were truly designated "good milkers." They are still bred for the Midland and Western dairies, and still present a rugged form, and can claim no character for early maturity. Such is the short-horn *dairy* cow, and such her small pretension to appear in a show-yard before judges in search of symmetry. The "*Improved Short-horn*" is an animal produced by cultivating the best races from the earliest times, with a view to produce a ponderous form for meat-making purposes—milk being a secondary object. It is produced only by eminent breeders, who possess that valuable mental quality—the power of accurate observation. This, together with sound judgment, decision, perseverance, and self-reliance, are essential to success in such a course. It has been the object of the improved short-horn breeder to produce males for the correction of the multitude of inferior short-horns scattered over our Midland and Northern counties. Bulls of this breed have also been sought for crossing both Scotch and Irish cattle, and they have been sent in considerable numbers for a similar purpose to the Continent, to America, and to the English colonies. Notwithstanding so large an exportation they still increase in numbers with us, and herd-book stories are springing up in every direction. When brought into severe competition, however, none but the best bred ones can win. The uses of the improved short-horn are familiar to all producers of green food and feeders in

the straw-yard. Their ponderous forms, rapid growth, and early maturity are the guarantee both for the economical conversion of vegetable food into flesh, and for the manufacture of first-rate manure for succeeding crops.

Let me try to describe a model specimen of the breed. He should have a symmetrical and compact form, of sufficient size, on shortish legs; the body should be covered evenly with flesh, of a mellow and elastic nature, yet firm enough and springy to the touch, following the fingers when the pressure is withdrawn; the forehead should be open, without a contracted air about it, and tapering gracefully to the muzzle; the eye prominent, yet placid; neck moderately long, neatly running into the shoulders, which should be well laid, gracefully fitting into the fore-quarters; the girth *good* over the heart; the forearm, where it joins the body, broad and tapering, with fine bone below the knee, and fitting level into the girth, and so maintaining a straight line along the whole animal to the extremity of the hip; the neck-vein should be prominent and well filled up with flesh, running neatly into the shoulder points, which should not be prominent (*i. e.* rough), but well covered, the muscle on the outside of the shoulder being well developed; the ribs should spring well and level from the backbone, increasingly so towards the back-rib, which should be well home to the quarter, in fact the space here (termed the false rib) should carry on in a straight line over the hip, gradually tapering to the side bones at the tail, but the quarter must be well packed, not "scooped out," so to speak; the hip bones should be dovetailed into the quarter and false rib so completely, that one ought to be at a loss where to find them, *i. e.* they should not be too recognisable; the flank will then, as I have already said, be deep and full, forming a parallel line with the animal's back from the bottom of the girth; the back, again, from behind the top of the shoulder all along the vertebræ should be well covered; the loins should be wide and thick; the bone or ridge along the quarter should form a straight line in continuation with the back, and should also be well covered (which in a great many animals it very imperfectly is) to the same level; the twist should be straight down (square), moderately wide and deep, containing a great deal of heavy flesh, and the legs should be well under the animal; there should be a thick coat of mossy hair, not sharp, or what is termed wiry. Altogether such an animal will have an ease and grace of motion as it walks which is only attained when the whole formation is in perfect harmony. There is invariably, too, a style and grandeur of appearance unmistakeably stamping the "high caste" short-horn. Many well-bred good animals will not feed level, but get patchy, which is fatal to them as show animals,

however stylish and fashionable in their outline. It is therefore indispensable that an animal should lay on flesh uniformly on every part so as not to spoil the proportion of the several parts. Rough shoulders are always accompanied by heavy, open shoulder-blades, and a slack bad girth, deficient through the heart as well as at the top of the plates immediately behind the shoulder. The animal is also sadly deficient in neck-vein, being weak and ill-filled where it joins the shoulder-points. Again, however good an animal is in all other respects, it is imperative that the hind-quarter be well finished and neat; nothing proclaims a low-bred character so distinctly as an ill-turned quarter. If the tail is not neatly set on, failing to come well out to form the square at the twist, you may be sure something is wrong. While, however, the tail is well set on, and the side bones sufficiently high to carry the flesh fully up to the level of the quarter, there should not be any redundancy to mark and separate the rumps from the adjoining quarter. The hind-legs must not be overlooked: if the hocks are too much bent, too long, or not well under the animal, it is a serious objection. The hind-legs should be nearly straight, and well under the animal; this not only looks well, but is a mark of strength as obviously as the reverse is one of weakness.

The six classes open for the reception of this breed of animals contained 163 entries, against 124 at the Chester Meeting.

Class I.—*Aged Bulls:* 34 competitors.—The first prize was awarded to No. 10, the property of Mr. Bradburne, Pipe-place, Lichfield, Staffordshire; the second to Colonel Pennant, Penrhyn Castle; and the third to Mr. Gooch, of Honingham, Norwich; there were also two others highly commended, and five commended. Considering the numbers entered in this class, and that they had arrived at maturity, the class collectively, or even individually, did not represent that unmistakeable character, fine appearance, and rent-paying properties that distinguished them in former years. This somewhat bold remark is fully supported by facts; high feeding will not compensate for loss of breeding; the animal is still the same in all that relates to style, quality of flesh, and symmetrical proportions. The prize bull was a round made animal, with a certain amount of good about him, but sadly deficient in the true characteristics of a pure shorthorn. The second bull, "Marmaduke," has trained off; still there is a good expression about him, resulting from his sire, the "Duke of Gloucester" (11,382).

Class II.—*Bulls under 2 years:* 25 entries.—This is at all times an interesting class in all that relates to the rising generation of short-horns. The three prize animals were worthy their distinction, especially the first prize bull, "Royal Butterfly,"

the property of Colonel Towneley, and the second bull, "Prince Talleyrand," the property of Mr. Henry Ambler, of Watkinson Hall; the third prize was awarded to Mr. Lynn, of Sproxton, near Grantham; there was a lack of expression about the remaining animals which wanted the decided stamp of a "short-horn," as represented by the young bull, "Royal Butterfly," as also by the high qualities and figure of the bull, "Prince Talleyrand." Many of the animals in this class were not so much wanting in symmetry as in grandeur. Rotundity may be carried too far; animals may be so compressed in shape that their symmetry becomes that of the ball, and little else.

Class III.—*Bull Calves:* 33 competitors.—This class brought together a long line of high-conditioned animals, which, if stripped of their superfluous fat, would be found wanting in robustness of constitution; neither had they collectively the fine form and growth seen on some former occasions. Mr. Fletcher, Mansfield, received the first prize, and Mr. Stratton, of Broad Hinton, the second, for his bull, No. 62. A second bull of Mr. Stratton's, No. 63, and Colonel Towneley's, No. 91, were highly commended.

Class IV.—*Cows in Milk or in Calf:* 24 entries.—The prize animals in this class reflected high credit upon their breeders, and were much admired by the public. There were also some other good specimens, viz., those of Messrs. Hutt, Colonel Pennant, Armstrong, Booth, Douglas, &c. Mr. Stratton's prize cow, "Matchless the Fourth," was shown in full bloom, and improved the high position she gained at Chester as the second prize cow in her class. Mr. Eastwood's second prize cow, "Rosette," was a splendid specimen of Mr. Wetherell's breeding at Aldborough, near Darlington; the third prize was awarded to Mr. Todd, of Elphinstone Tower, for his cow, "Volga," bred by Mr. Stewart, near Dumfries. The cow class, collectively, was about an average one in quality; the entries were increased from 12 at Chester to 24 at Warwick.

Class V.—*Heifers under 3 years old:* 17 entries.—Amongst these were many important names, and the class generally stood in high repute. I speak from observation (my duties as steward in the horse department having been close at hand) when I say that this class appeared by far the most difficult to judge; some eight or ten magnificent animals were first paraded before the judges, and when reduced to about half that number, the real difficulty in the award became apparent. They were bound to adhere to principles, and thus make a consistent award to such animals as possessed the highest pitch of excellence for breeding purposes. Quality of flesh, lightness of offal, and unmistakeable elegance having been the foundation of their opinions in the pre-

ceding classes; there was some difficulty in placing a robust and strong-grown animal in a leading position over those with more symmetrical proportions. Such an animal must be placed first, or not mentioned at all; hence the result. The first prize was awarded to Colonel Towneley's "Fidelity," a worthy daughter of the justly celebrated bull, "Frederic," out of "Vestris the Third." Mr. Fowler, near Biggleswade, received the second prize for "Daisy," a very even and well-proportioned animal, while the third prize was awarded to Colonel Towneley's "Pearl," a beautiful animal. The Colonel also received a high commendation for his heifer "Emma." Two other heifers, the property of Mr. Douglas and Mr. Marjoribanks, were very highly commended. Nos. 119, 124, and 128, the property of Messrs. Marjoribanks, Captain Gunter, and E. Bowley, were severally commended. The judges also commended the class generally.

CLASS VI.—*Yearling Heifers:* 30 entries.—Here, again, we had a splendid collection of heifers, the whole class being generally commended by the judges. The three prize animals, viz., Mr. Grundy's "Faith" (first), Mr. Douglas's "Maid of Athelstane" (second), and Captain Gunter's "Duchess Seventy-Seventh" (third), were indeed magnificent animals. To show the importance of this gathering of heifers, I may name that there were also five highly-commended animals in this class, which represented the names of Messrs. Grundy, Stratton, Hon. and Rev. T. H. Noel Hill, Colonel Towneley, and Jonas Webb. To review the respective qualities of these animals would be tedious. Public opinion went far to extol this rising generation of Short-horns, but was equally severe upon the aged bulls and many of the breeding cows.

HEREFORDS.—What is a Hereford? Although a few years since there were four distinct sorts, each having its admirers, and each brought to a high state of perfection by the assiduous attention of their respective breeders, the breed now presents an almost uniform appearance. Being occasionally reminded of these classes at Warwick, I have taken some pains to trace (through the medium of the 'Hereford Herd-book') the pedigrees of all the prize and commended animals in each of their classes. This resulted in a fact worthy of notice, and one which strongly indicates the intrinsic value of that work, viz., that as far as I was able to trace them, every animal noticed by the judges claims a near relationship with either the light grey, the dark grey, or the mottled-face variety, and in some cases with all three; yet, with the exception of Mr. Roberts' light grey heifer, "Gipsy Queen," they presented the uniform appearance which characterises the true-bred Hereford. The face, mane, throat, the under portion

of the body, the inside and lower part of the legs, and the tip of the tail, are beautifully white; the other parts of the body a rich red, usually darker in the male than the female; the horn is white or light yellow, of a waxy appearance, sometimes tipped with black. The forehead is broad, with spreading horns: those of the bull straight and level with the poll, and of the ox and cow slightly curved, with an upward tendency. The eye is full, yet of a passive expression, denoting the quietness of disposition and temper characteristic of the Hereford, and which is of paramount importance to insure the profitable feeding of all ruminating animals. The cheek is fine, the head small in proportion to the carcase, which is long, level, and cylindrical. The hide is thick, yet mellow and well covered with moderately long soft hair, having a tendency to curl. The brisket is prominent, the chest well expanded, and the breed is pre-eminently distinguished for neatness of shoulder, the bone being thin and flat, the kernel full up, the outside shoulder well covered with mellow flesh; the chine good, the loin broad, the hips wide and level, the whole back displaying a straight line, well covered with flesh from the neck to the tail. The twist flank and fore flank are good, the outside thigh is perhaps the most defective part. The whole body is well covered with rich mellow flesh, yielding with pleasant elasticity to the touch. The legs are short and the bone small, and the whole contour displays great constitution, and exhibits perhaps a larger amount of flesh in proportion to bone than any other breed.

This race of cattle has long been celebrated for its steers and oxen. When the ox was the principal moving power of the plough, this breed was held in high repute. The Hereford being a mild, docile animal, he was readily managed, and his power, combined with activity, rendered him valuable for this purpose. Where this system of cultivation continues in use he is still a favourite, but the wants of a rapidly increasing population now require him to pass into consumption at an earlier age, and the improved system of cultivation renders it more desirable to use the more active animal the horse, in his turn now giving way to the mighty agent steam. The Hereford steer is consequently now principally sought after for his beef-producing properties, for which his scale of form, early maturity, and aptitude to fatten, render him highly distinguished. Youatt, "On Cattle," alludes to a sale of Hereford oxen for the London market in 1694; and at the first meeting of the Smithfield Club, in the year 1799, Mr. Westcar won the first prize with a Hereford ox, which was afterwards sold for 100 guineas; he was 8 ft. 11 in. long, 6 ft. 7 in. high, and 10 ft. 4 in. in girth. Another, exhibited at the same meeting, was 7 ft. high and 12 ft. girth, and from the formation

of this club to the year 1851, being the last year in which the different breeds were shown in competition, the Hereford steers and oxen won 185 prizes, the Short-horns 82, the Devons 44, the Scotch 43, the Sussex 9, the Long-horns 4, the Cross-breeds 8; making a total of 190 prizes for all other breeds, or only 5 more than were awarded to the Herefords alone.

Allusion was made in the Chester Report to the deficiency in the milking properties of the cow: this arises from the fact of breeders paying greater attention to their feeding than their milking properties; but there are pure-bred herds in dairy districts where proper attention has been paid to them (the produce being reared by hand instead of sucking their dams) that have resulted satisfactorily to their owners, as they stock their land thicker, and thus gain more from the increased number of animals reared than they lose in the dairy produce. This has been proved by carefully tried experiments, one of the earliest of which is recorded by Youatt.* The best Herefords being small consumers, and of good constitution, are well adapted for cold situations, yet, like all other animals, the better they are kept the better they thrive, and the quicker is the return they yield.

The Hereford classes contained some very choice specimens of the breed, and, as a whole, no class of animals attracted so much attention. Until within the last four or five years they were shown in limited numbers, principally from the county whence they take their name. This year they numbered 89. Those from the herd of H.R.H. the Prince Consort were highly deserving the distinction paid them by the judges. The entries extended over a broad space of country, viz., Salop, Montgomery, Radnor, Monmouth, Gloucester, and Warwick, many of them exhibiting successfully. It is a singular fact that "other counties" equally divided the prizes and commendations with those sent from Herefordshire, thus proving the fallacy of the statement, that they will not succeed when bred out of their own county.

Class I.—*Bulls not exceeding 6 years old:* 11 entries.—The first prize was awarded to Mr. Hill's "Claret," winner of the first prize as a yearling at Chester. He possesses a mass of heavy flesh and great depth of carcase, his girth of 8 ft. 5 in. being above the average for his age, which was only 2 years 10 months; yet he was short, and inclined to become unlevel. Lord Berwick's "Severn," winner of the second prize, was a remarkably fine level animal, and this may also be said of Mr. Williams' "Sir Colin." H.R.H. the Prince Consort's "Windsor," as

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* Youatt 'On Cattle,' p. 34.

also Mr. Naylor's "Lucknow," commended, were good specimens of the breed; the latter, however, being rather high in the rump, and the former rather deficient in that point.

CLASS II.—*Bulls more than* 1, *but under* 2 *years of age:* 20 entries.—Mr. J. Naylor's "Adjutant," winner of the first prize, was a level, heavy-fleshed animal, rather too full on the loin, and not so good in his girth or brisket as Mr. Perry's second prize animal "Salisbury." Mr. Edwards' "Leominster," winner of the first prize as a bull calf at Chester, was awarded the third prize at Warwick.

CLASS III.—*Bull Calves:* 16 entries.—H.R.H. the Prince Consort's "Maximus," winner of the first prize, is a heavy-fleshed animal, displaying great constitution. Mr. C. Vever's "Stratagem," the third winner of the second prize, has a good skin and hair of fine quality; his back hardly so good as that of "Maximus." Lord Berwick's "Thickset," highly commended, was a beautifully level little animal. Lord Bateman's "Sir Howard" and "Warwick," both commended, were good scions of the stock of their noble sire "Carlisle."

CLASS IV.—*Cows in Milk or in Calf*: 15 entries.—Mr. F. Rea's "Bella" was the admiration of all who beheld her; level as a Devon, yet of the size of a short-horn, as was proved by her girth, one inch more than that of Mr. Stratton's prize cow "Matchless the Fourth." Lord Berwick's "Beauty" was deservedly second: she belongs to a family frequently seen at these meetings, but never before without gaining first honours; here she was fairly beaten by one of the best Herefords we have ever seen. Mr. Rees Keene's "Beauty" was a fine specimen of her breed, but we have seen her look better, as at Cardiff last year, when she won the first prize at the Bath and West of England Meeting. Mr. G. Pitt's "Perfection" nearly approached her name, being, however, rather small; she was highly commended; his "Countess" and Mr. P. Turner's "Graceful" were commended.

CLASS V.—*Heifers in Milk or Calf;* 10 entries.—Mr. J. Rae's "Czarina" was the type of a first-class animal. Lord Berwick's "Ada," like her sister "Beauty," was here again of necessity placed in a secondary position. Mr. Nayler's "Laura," winner of the third prize, promises better things at some future gathering. The same may be said of Lord Bateman's "Vesta" and Mr. Roberts' "Gipsy Queen," both highly commended.

CLASS VI.—*Yearling Heifers:* 17 entries.—Mr. Price's "Well-a-day" displayed the great substance so much admired at Chester in her sire "Goldfinder the Second;" like him, she commanded a first position. The Rev. A. Clive's "Laura the Second," and Mr. Wright's "Silver the Third," were each hand-

some and neat specimens ; as also Mr. Price's "Miss Coningsby" and Mr. Turner's "Countess," highly commended, together with Mr. Rea's "Diadem," commended. There was another in this class which we expect to see again in a different position, viz. Mr. Williams' "Barmaid."

Devons.—Although so little has been written on it, the improvement of the Devon has not been neglected ; on the contrary, its breeding has been studied like a science, and carried into execution with the most sedulous attention and dexterity for upwards of 200 years. The object of the Devon breeder has been to lessen those parts of the animal frame which are least useful to man, such as the bone and offal, and at the same time to increase such other parts (flesh and fat) as furnish man with food. These ends have been accomplished by a judicious selection of individual animals possessing the wished-for form and qualities in the greatest degree, which being perpetuated in their progeny in various proportions, and the selections being continued from the most approved specimens among these, enabled the late Mr. Francis Quartly at length to fully establish the breed with the desired properties. This result is substantially confirmed by the statistics contained in Davy's 'Devon Herd-Book.' We have been curious enough to examine these pedigrees, and find that nine-tenths of the present herds of these truly beautiful animals are directly descended (especially in their early parentage) from the old Quartly stock. Later improvements have been engrafted on these by the Messrs. Quartly of the present day. The example of various opulent breeders and farmers in all parts of the county has tended to spread this improvement, by which the North Devon cattle have become more general and fashionable. The leading characteristics of the North Devon breed are such as qualify them for every hardship. They are cast in a peculiar mould, with a degree of elegance in their movement which is not to be excelled. Their hardihood, resulting from compactness of frame and lightness of offal, enables them (when wanted) to perform the operations of the farm with a lively step and great endurance. For the production of animal food they are not to be surpassed, and in conjunction with the Highland Scot of similar pretension, they are the first to receive the attention of the London West-end butcher. In the show-yard, again, the form of the Devon and its rich quality of flesh serve as the leading guide to all decisions. He has a prominent eye, with a placid face, small nose, and elegantly turned horns, which have an upward tendency (and cast outwards at the end), as if to put the last finish upon his symmetrical form and carriage. These animals are beautifully covered with silky coats of a medium red colour. The shoulder

points, sides, and fore-flanks are well covered with rich meat, which, when blended with their peculiar property of producing meat of first-rate quality along their tops, makes them what they are—"models of perfection." Of course, we are here only speaking of the best-bred animals. Some object to the North Devon, and class him as a small animal, with the remark, "He is too small for the grazier." In saying this it should ever be remembered that the Devon has his particular mission to perform, viz. that of converting the produce of cold and hilly pastures into meat, which could not be done to advantage by large-framed animals, however good their parentage. The Devon may thus be designated the "pony" of the ox tribe.

CLASS I.—*Aged Bulls:* 9 entries.—There were some good average animals in this class, but nothing extraordinary. Mr. Farthing's (of Stowey Court, Bridgewater) prize bull was a thick massive beast, and looked well when moving before the judges. The second prize bull, the property of Mr. John Quartly, of Molland, was also a good animal, upon remarkably short legs, with full points, and of an excellent constitution. This bull received the first prize as a yearling bull at the Chester Meeting, where he was much admired. The third prize was awarded to Mr. Foreacre, of Durston, near Taunton, for a 5 years old bull, bred by Mr. Bodley, of Stockley-Pomeroy. Mr. J. Merson's bull was commended. This animal, from some cause or other, did not show to advantage; he appeared to have suffered from the journey.

CLASS II.—*Young Bulls*, 9 entries, which contained some useful animals. Mr. John Quartly, of Molland, South Molton, received the first prize for a very deep and promising young animal, out of the cow "Curly," by the "Earl of Exeter." The second prize was awarded to H.R.H. the Prince Consort, for his young bull "The Colonel," by the "Zouave," dam "Rosa." Mr. Hole, of Hannaford, Barnstaple, received the third prize for "Ikbal," bred by himself from the cow "Marmoset." Mr. S. Umbers' bull, No. 265, was commended.

CLASS III.—*Bull Calves:* 6 entries.—This was an interesting class; still the animals appeared rather below their usual standard. The first prize was awarded to Mr. Hole, of Hannaford, and the second to Mr. G. Turner; Mr. S. Umbers' was commended.

CLASS IV.—*Breeding Cows:* 5 competitors.—This was a small class, but contained several good animals. Mr. Merson's (North Molton) cow was first; Mr. Farthing's, of Stowey Court, second; and Mr. J. Quartly's (Molland), third; Mr. Umbers' cow was commended. The prize cow was a substantial animal, and looked well when led out before the judges; her quality was

thought a little too soft, but in other respects she was much admired. The second cow was also a robust animal. Mr. Quartly's cow was much admired for her quality of flesh and style of animal.

Class V.—*Heifers in Calf or in Milk:* 7 entries.—This was a most difficult class to judge. When these 7 heifers were paraded before the judges, they formed a most beautiful and picturesque group of symmetrical animals. From these the judges selected Mr. James Quartly's beautiful heifer, "The Gem," as their first choice; Mr. G. Turner's (of Barton) "Vaudine," as second; and Mr. E. Pope's (of Great Toller) "Fancy the Third," as their third best; and then highly commended Mr. Hole's heifer, of Knowle House, Dunster, as also the class generally. "The Gem" was also first favourite in the yearling class at Chester, and "Vaudine" the second. It is interesting to mention that the parents of "The Gem" were both prize animals at the Bath Meeting of the West of England Society in 1855: her sire, "Napoleon" (259), was first in the young bull class, and her dam, "Graceful" (759), was first in the in-calf heifer class. The cow "Graceful" subsequently received the first prize in the cow class at the Royal Agricultural Society's Meeting at Salisbury. Such is the result of pure breeding.

Class VI.—*Yearling Heifers:* 9 competitors.—In this class we had at least two *magnificent* heifers, viz., Mr. J. Quartly's prize heifer, and the second prize heifer, the property of H.R.H. the Prince Consort. Mr. Mildon, Woodington Farm, Devon, received the third prize for an excellent heifer closely descended from the Quartly stock. A heifer of Mr. J. Quartly's was highly commended. Too much cannot be said of the prize animals; they were constantly admired by the public. As a whole, the heifer classes formed the chief attraction amongst the Devons.

Other Established Breeds.

Class I.—*Aged Bulls:* 6 entries.—These embraced specimens of the Sussex, Welsh, Polled Angus, Alderney, and Norfolk polled breeds. Colonel Pennant, of Penrhyn Castle, received the prize for his black bull "Llewellyn." The Earl of Southesk's polled Angus was highly commended, and the Alderney exhibited by the Prince Consort commended.

Class II. — *Young Bulls:* 4 entries. The prize was awarded to a beautiful Jersey bull, the property of Mr. Turville, of Hartley Park. Lord Sondes' polled Norfolk was commended.

Class III.—*Milking Cows.*—This prize was awarded to the Earl of Southesk for his polled Angus cow. Mr. Hawkes' long-

horn was highly commended, and Rev. R. T. Forrester's Alderney was commended.

CLASS IV. — *Heifers under 3 years:* 3 entries, two polled Norfolks and a Sussex.—Lord Sondes' polled Norfolk received the prize.

CLASS V.—*Yearling Heifers:* 4 entries.—The Earl of Southesk received the prize for a polled Angus. Lord Sondes' polled Norfolk was highly commended. These to a certain extent are useful classes, as the refuge for the remaining "other breeds;" still they have as yet been wanting in public interest.

The following Table states the age and girth of the first prize animal in each of the classes of "Established Breeds" of Cattle:

Class.	Number of Entries.	Age of Prize Animal.		Girth of Prize Animal.	
		Yrs.	Months.	Ft.	Inches.
SHORT-HORNS.					
Aged Bulls	34	4	0½	8	6
Yearling Bulls	25	1	10½	7	7
Bull Calves	33	0	9½	5	9½
Cows in Milk or Calf ..	22	4	3	8	0
Two year old Heifers ..	16	2	1½	7	6½
Yearling Heifers	29	0	9½	7	1
	159				
HEREFORDS.					
Aged Bulls	11	2	10¼	8	3
Yearling Bulls	20	1	9¾	7	3
Bull Calves	16	0	11½	6	1
Cows in Milk or Calf ..	15	3	7	8	1
Two year old Heifers ..	10	2	8¼	7	4
Yearling Heifers	17	1	5½	6	5
	89				
DEVONS.					
Aged Bulls	9	2	6	7	5
Yearling Bulls	9	1	2	6	0
Bull Calves	6	0	8¾	5	1
Cows in milk or calf ..	5	6	9	7	4
Two year old Heifers ..	7	2	6	6	8
Yearling Heifers	9	1	6	6	3
	45				

SHEEP.

LEICESTERS.—The leading qualities of the Leicesters are early maturity, lightness of offal, aptitude to fatten, and small consumption of food; producing consequently a larger amount of mutton per acre than any other breed. As improvers of other breeds they are invaluable; indeed, there are but few (if any) long-woolled sheep that do not owe something to the Leicester.

The Leicester of the present day is much altered. The late Mr. Bakewell confined himself to symmetry and mutton-producing qualities, consequently thin necks and light wool were produced as a rule, while they are now the exception. But had Bakewell lived he would doubtless have *moved on* like those who have succeeded him. The real essentials, as combined in a good Leicester, are:—Head well set on, wide across the forehead, but not too short; fine bold eye; neck very muscular and wide at the base, not too short (a very short neck being in my opinion a mistake); moderately wide between the top of the shoulders; shoulders oblique; chest wide; fore-flanks widely developed; ribs springing well from the vertebræ; loin wide and well covered; rumps wide, and a little projecting over the tail; thighs large and well let down, and with what is provincially termed a good "twist;" wool long and thickly set, with rather a curly lock; carcase deep and round, and with an unmistakeable appearance of good character.

Class I.—*Shearling Rams:* 36 entries.—Amongst these were specimens from nearly all our leading breeders. The three prizes of 20*l.*, 10*l.*, and 5*l.*, were all awarded to Mr. Sanday, Holme Pierrepont. As a class they were not so good as usual, still there were some excellent sheep amongst them. Mr. Pawlett's sheep were not up to their usual standard in condition. Mr. Cresswell exhibited four rent-paying sheep of good size and wool, but scarcely firm enough for the judges. Messrs. G. Turner, F. Spencer, S. Spencer, G. Radmore, and J. Borton exhibited useful animals.

Class II.—*Aged Rams:* 47 competitors!—Here, again, we had some capital specimens of the Leicester breed, exhibited by nearly all the leading breeders. Their frames in general were well developed, especially those sent by Messrs. Sanday, Pawlett, and Turner. The two first prizes were awarded to Mr. Pawlett for his two shear rams, and a third to Mr. Sanday for a 4-year old sheep. Two others exhibited by Mr. Sanday were highly commended. These animals were particularly true in their form and quality, especially the third prize sheep, No. 519. The public were loud in their praise of this sheep, and some went so far as to pronounce him the best Leicester in the yard. Mr. V. Barford exhibited three aged rams in this class, which had been produced from his Foscote flock, without a cross for upwards of sixty years. These were valuable animals, of vigorous constitution; the form of the chest was most remarkable in them.

Class III.—*Shearling Ewes:* 10 entries.—Mr. Sanday carried off two prizes, while Colonel Inge received the third. They were all good specimens, especially the first prize pen; these were

truly beautiful in their form and quality, and at once proclaimed their close alliance to Mr. Sanday's prize rams.

THE SOUTHDOWN.—This sheep is now fully recognised as a first-class animal, combining beauty of form, quality of wool and flesh, with elegance of movement. As such, they are much sought after for grazing our English parks, and adorning the seats of the aristocracy and country gentlemen. Again, for the "home farm" they are just the thing, combining, as they do, park-like beauty of appearance and delicious flesh for the squire or connoisseur. No breeders are so tenacious on points of colour, bone, elegance of shape, beauty of features, and quality of wool, as the Southdown breeders. The colour of his face must be a peculiar brown, neither too light nor too dark, either being objectionable; the wool must be close and fine, but in tolerable quantity, and, to use a provincial expression in the county of Sussex, it should be "as hard as a board;" the head must be well covered with wool, particularly between the ears, and carry a nice "fore-top" on the forehead. The most striking fault in many Southdown flocks is a very ill-formed shoulder, light fore-quarter, light in the brisket, and narrow between the fore-legs. No man has done so much towards remedying this defect as Mr. Jonas Webb, his flock being particularly good in this respect. The brown leg and foot is another peculiarity of the breed, as also the deeply let down "haunch of mutton," not forgetting the dark rich gravy that "cures the gout." The setting on of the neck, when nicely blended with the shoulder, gives these sheep a remarkable elegance of carriage. Thus it is that these animals are so prepossessing in appearance. The general contour of the best animals is very beautiful, but of the unimproved (and there are many) we may say that they still inherit the forms of their grandsires of many generations back, of which Loudon, in his Encyclopædia, on the 'Varieties of British Sheep,' p. 1051, says, in 1830:—

"The Southdown sheep are without horns, they have dark or black grey faces and legs, fine bones, long small necks, are low before, high on the shoulder, and light in the fore-quarter; the sides are good, and the loin tolerably broad, backbone too high, the thigh full, and twist good. The fleece is very short and fine, weighing from $2\frac{1}{2}$ to 3 lbs. The average weight of 2-years-old wethers is about 18 lbs. per quarter, the mutton fine in the grain, and of an excellent flavour. They prevail in Sussex on very dry chalky downs, producing short fine herbage. These sheep are being improved by Ellman of Glynd, and other intelligent breeders."

Thanks to such breeders as Ellman, Grantham, Webb, Rigden, the Duke of Richmond, Overman, Sainsbury, &c., for redeeming this breed of sheep from its original characteristic of an open

field or down sheep. In the Chester Report full mention was made of the successful career of the Goodwood and Babraham flocks. These flocks have now an important rival in the Hove flock near Brighton, whose owner, Mr. Rigden, has of late been singularly successful at our national gatherings.

CLASS I. — *Shearling Rams:* 34 entries.—In this class the Duke of Richmond received the first prize against the veteran breeder, Mr. Webb, who succeeded in carrying off the remaining 2 prizes and a commendation. There was a diversity of opinion in this class; the public had many "bests:" with some, the Duke's sheep was far away the best, while others found their favourite in the Babraham flock. It was truly ludicrous to hear the conflicting opinions passed upon these sheep, each admirer having his own stamp and style of a Southdown.

CLASS II.—*Aged Rams:* 15 entries.—The Duke of Richmond carried away the first prize, while Mr. Rigden was close at hand with a second and third prize animal, and a commendation. The prize sheep were good specimens, but beyond these little can be said, except that the class contained many plain animals. Surely these remaining specimens might be corrected in their bodies; they want another rib or two to hold them up.

CLASS III.—*Shearling Ewes:* 10 entries.—Here, again, the Duke of Richmond received the first and second prizes, and Mr. Rigden the third; Sir R. G. Throckmorton's ewes were highly commended, and those of the Duke of Beaufort commended. In this class we had 5 pens of ewes, which were good specimens, and 5 pens of a moderate order.

LONG-WOOLLED SHEEP.—This is an open class for all the long-woolled breeds, such as the Cotswolds, Lincolns, Kents, &c., but it was represented by the Cotswolds alone, not a Lincoln or Kentish sheep being upon the ground. The answer to What is a *Lincolnshire* sheep?—was best told by the 66 entries at the Lincoln meeting. These specimens, it will be remembered, went far to combine the true essentials of these long-woolled sheep; they were upstanding in their form and carriage, had immense frames, with a good proportion of lean meat, covered by long and heavy fleeces of wool. Their long clean face and ear, set upon a muscular neck, gave them many admirers, as also did their robust forms, for the purposes of the farm, and that of supplying meat for the million, and long wool for the factory. This breed of sheep requires to be better known. I would suggest that it would pay any breeder of long-woolled sheep to visit the Lincolnshire sheep fairs in the spring of the year. These occur about April, and are held at Lincoln, Caistor, Boston, Grantham,

&c. I give a short extract from the Chester Report:—"I have known 14 months' old lamb-hogs slaughtered at Lincoln April Fair, 30 together, averaging 35 lbs. per quarter, and have known 100 together clip 14 lbs. each of washed wool." Of the *Kentish sheep* we can say but little more than that they are a popular breed in Romney Marsh, and other localities around, and certainly supply extraordinary fleeces of wool for the market. The Society has judiciously opened suitable classes for their exhibition at Canterbury, so that the general public may have an opportunity of seeing them.

The Cotswolds.—Some account of the history of these sheep was given in the Chester Report. But it may yet be asked by those who are not familiar with the breed, What is a Cotswold sheep, &c.? The general characteristics of the best Cotswolds are—their bold and commanding appearance; their finely-arched neck, well run into the shoulders, giving them an ease of carriage, when walking, which is peculiarly their own. They have broad straight backs, with arched ribs and length of quarter, carrying an enormous weight of carcase upon clean yet open legs. As a class, they possess good legs of mutton. Their shoulders are rather open, but in line with the back, thus giving them a good appearance in the sheep-pen; the chest is broad and deep. There is a slight difference of opinion as to the exact sort of wool they should produce. A fashion of late has sprung up in favour of the open curly coat, while the older breeders adhere to the thick-set flaky coat. The latter class of wool affords the best protection against the vicissitudes of storms upon the open hill lands these sheep have to occupy. Be this as it may, they are fully agreed as to the animal carrying a "fore-top" on his forehead, and of no small dimensions, as witnessed at some of the Society's meetings. These sheep have become popular from the fact of their hardiness being combined with flesh and wool producing properties. They are sought after for exportation to the colonies, and for crossing the dark-faced short-wools at home. The Oxfordshire down was originated by a cross between the Cotswold ram and Hampshire down ewe.

Class I.—*Shearling Rams:* 44 entries.—Unfortunately these entries (numerous as they are) were all from one class of breeders —those of Cotswolds. In so large a lot there were naturally good and moderate animals. As a class they were not equal to that at Chester; many of the animals were wanting in solidity of form and quality; the wool was deep, and the mutton shallow. The first and second prizes were awarded to Mr. Robert Garne, of Aldsworth, near Northleach, and the third to Mr. Fletcher, of Shipton Sollars, near Cheltenham. There were also nine other

animals noticed by the judges. They highly commended Mr. Garne's sheep, No. 659, Mr. Walker's, 642, and Mr. J. Gillett's, 636. They also commended two of Mr. Handy's, two of Mr. Fletcher's, and one each of Messrs. J. Gillett's and T. Porter's. Mr. Garne's sheep appeared especial favourites with the public, especially his sheep No. 659. This sheep received an injury on his journey, and could not well be shown to advantage when the award was made, otherwise he must have been first in the class. The sheep shown by Messrs. Walker and Gillett possessed great substance, and were, indeed, valuable animals.

Class II.—*Aged Rams:* 19 entries.—Some of these were of enormous dimensions, while others, if stripped of their nicely-trimmed fleece, would be found sadly wanting in form and quality. The judges selected nine for special notice. The first prize was given to Mr. Porter of Baunton, near Cirencester; the second to Mr. R. Garne, of Aldsworth; and the third to Mr. Fletcher, of Shipton Sollars. Two of Mr. Handy's, near Cheltenham, were highly commended, as also one of Mr. Porter's. Three others were commended. Mr. Handy's rams were favourites with the public.

Class III.—*Shearling Ewes.*—Out of 10 entries shown by 6 breeders, 8 pens were noticed by the judges; still, the class was not up to former years. The first prize was awarded to Mr. Walker, the second to Mr. Lane, and the third to Mr. Fletcher. In addition to these awards there were two pens highly commended, and three commended. This class is not a popular one with the breeders; they dislike running the risk of spoiling their best young ewes for breeding purposes. From the above award it will be shown that Mr. Garne was the winner of one first and two second prizes (fully maintaining the reputation of his flock); Mr. Fletcher, third honours in each class; and Messrs. Porter, Walker, and Lane, a prize each.

Short-woolled Sheep, not Southdowns.—Amongst the "other short-woolled sheep" exhibited, we have Hampshire Downs, Oxfordshire Downs, West-country Downs, Shropshires, Sussex, and Cotswold, &c. These several breeds require notice as to their origin and qualities. The Hampshire Down is a native of that county, and one of the earliest of its families—see the Chester Report.

The Oxford Downs date from the year 1833 (see 'Royal Agricultural Society's Journal,' vol. xiv. p. 211), when a neat, well-made Cotswold ram was used with Hampshire ewes; at that period several breeders of sheep tried the same experiment, which, by subsequent attention, has resulted in the establishment of this "rent-paying" class of sheep. Amongst these

breeders may be mentioned His Grace the Duke of Marlborough, Messrs. G. J. Gaskell, H. Barnett, J. Roberts, C. Gillett, J. Bryan, John Hitchman, William Gillett, W. Hobbs, A. Edmonds, C. Howard, William Hemmings, and Samuel Druce, of Eynsham.

Some excellent sheep of this breed have been shown at the various meetings, but their career has been most noticed in the yard of the Smithfield Club Cattle Show. As fat wethers they have again and again astonished the public, while the prize ram exhibited by Mr. Druce at Warwick went far to recommend them as male animals.

The following Table gives the girth of the first prize animals in each of the classes for the "Established Breeds" of sheep:—

Class.	Number of Entries.	Age of the Prize Animals.		Girth of the Prize Animals.	
		Yrs.	Months.	Ft.	Inches.
LEICESTERS.					
Shearling Rams	36	1	4	4	7
Aged Rams	47	2	4	5	3
Shearling Ewes	10	1	4	4	2½
	93				
SOUTH DOWNS.					
Shearling Rams	34	1	4	4	4
Aged Rams	15	3	4	5	0
Shearling Ewes	10	1	4	4	1
	59				
LONG-WOOLLED SHEEP (All Cotswolds).					
Shearling Rams	44	1	4	5	1
Aged Rams	19	3	4	5	11
Shearling Ewes	10	1	4	4	9
	73				

West-country Downs.—This is a new stamp or breed of sheep, created by Mr. Humfrey, of Oak Ash, near Wantage. They originated with the Hampshire, from a cross between the pure Sussex Down ram and the old Wiltshire horned ewe, and the Berkshire large ewe without horns. They are of better form, quality, and style than the old Hampshire. They combine the great essentials necessary for the occupation assigned to them—that of "hard work" in a down country. Their faces and legs vary from a pale brown to a dark brown colour. Their carcase is of a substantial cast, they stand high and carry good fleeces of wool. Their robustness of form represents a good amount of lean meat, and at 14 to 16 months old they weigh from 10 to 14 stone.

As lambs, in the month of September, they have fetched enormous prices, many lots in the last year having fetched from 40*s.* to 47*s.* each.

Mr. Humfrey's chief supporters are the Messrs. King, near Hungerford, Berks; Mr. Canning, of Chisledon, Wilts; Mr. J. Rawlence, of Wilton; Mr. E. Waters, of Salisbury; Mr. William Raunton, of Downton; Mr. W. Waters, of Boscombe; Mr. C. Vernham, of Andover; and, as to the original Hampshire breed, Mr. Budd, of Basingstoke; Mr. Holding, of Amesbury; Mr. Edney, of Whitechurch; Mr. Brown, of Ufcot, &c.

The Sussex and Cotswold cross is yet in its infancy. Some account of the Shropshire sheep will be given in its place, when reviewing the Shropshire classes under the head of "Special Prizes" given by the local committee.

Class I.—*Shearling Rams:* 68 entries! comprising all the preceding sorts of short-woolled breeds. With such a combination of sorts, it is utterly impossible for judges to please themselves, much less the breeders and the public. For instance, they must first determine upon "the sort" of animal to be selected from the many breeds as a true type of what this class of animal ought to be; this done, many difficulties arise. They are bound to adhere to their text and principle, so that, if they commence with a Shropshire or other down in a class, they are naturally desirous to find others of similar character, and thus continue the same line of qualities. Hence we find that in a good and extensive class of selected specimens, one stamp of animal receives the prizes, as also a high commendation. These remarks are given advisedly, knowing that such intricacy of competition is a plague to the judges. With a view to confirmation I give an extract from the Chester Report of 1859, when reviewing these "other short-woolled sheep:"—

> "Class I.—*Shearling Rams:* 61 entries.—These were composed of Hampshires, Oxfordshires, Shropshires, West-country Downs, and Cheviots. It was, indeed, a task for the judges to compare 61 animals of different breeds, breed against breed, size against symmetry, and both against the lean but respectable mountain Cheviot."

The prizes this year were all awarded to Mr. Humfrey, of Oak Ash, near Wantage, for his West-country Downs. The girths were—4 ft. 4 in., 4 ft. 5 in., and 4 ft. 4 in., in the cases of the 1st, 2nd, and 3rd prize-animals, respectively.

Mr. Humfrey had a fourth sheep highly commended. There were 6 other sheep noticed by the judges. About the middle of this long line of varied breeds were some splendid Shropshire Downs, shown by Mr. Adney, of Harley, and Messrs. James and Edward Crane, of Shrawardine.

The Oxford Downs shown by Messrs. Howard and Druce were well worthy of the especial notice they received.

CLASS II.—*Rams of any Age:* 27 entries.—In this class we had again a similar mixture of the "other short-woolled breeds." The prizes went to three different breeds, viz.:—The 1st to Mr. S. Druce, of Eynsham, for his Oxfordshire Down; the 2nd to Mr. Humfrey, for his West-country Down; and the 3rd to Mr. Adney, for his Shropshire Down. Three Oxfordshire Downs were also highly commended. This was an excellent class of sheep, and very properly "generally commended" by the judges.

The following was the girth of the prize-animals:—

Mr. Druce's 2 years and 5 months Oxfordshire Down .	4 ft.	10	in.
Mr. Humfrey's 3 years and 4 months West-country Down	4 ,,	9	,,
Mr. Adney's 2 years and 3½ months Shropshire Down .	4 ,,	8	,,

Among other competitors—

Mr. Merson's 3 years and 3 months Exmoor ram girthed	3 ft.	8½	in.
,, 4 ,, 3 ,, ditto . .	3 ,,	10½	,,
Mr. Sturgeon's 2 years and 4 months Merino (in wool) .	4 ,,	5	,,

CLASS III.—*Shearling Ewes:* 26 entries.—This class was also "generally commended" by the judges. It contained superior specimens of all the breeds, consequently they were difficult to judge. Eventually the 1st prize was awarded to Mr. Humfrey, for his pen of West-country Downs; the 2nd to Mr. S. King, near Hungerford, for his West-country Downs; and the 3rd to Mr. Canning, Swindon, for his improved Hampshire Downs. There were also six high commendations in this class. Amongst them we noticed some beautiful Shropshire ewes, shown by the Messrs. Crane; also a pen shown by Mrs. Baker, of Grendon. The Oxford Down ewes shown by Mr. E. Miller, Oxford, were also capital specimens.

THE HORSES.

This animal is by far the most important of the brute creation. As the servant to man he has long been domesticated, and cultivated in most parts of the earth for the purposes of war, hunting, and parade, for the saddle and for draught. The native horse of every country, operated upon by climate, assumes that form best adapted to its locality and uses. We have thus our established breeds for established purposes, such as the heavy or active cart-horse for the farm or the dray, the hunter, the hack or roadster, the cob and galloway, the pony, &c. The race-horse belongs to an amateur class of breeders whose delight is speed and elegance of outline. The varieties of draught horses were originally as numerous as the districts in which they were

bred, each having its favourite; but since the intercourse amongst farmers and breeders has been greater, they have been reduced to a few of the better and now "established breeds," such as the Lincolnshire dray-horse, the Suffolk and the Clydesdale horse. The hunter is derived from horses of entire blood, or such as are little removed from it, uniting with mares of substance, correct form, and good action. In some instances hunters are derived from large mares of the pure breed propagating with powerful stallions of the old English roadster, when he can be found. The hackney is derived, like the hunter, from a judicious mixture of "blood" with the native horse, especially the "pack-horse," familiar in mountain districts. Norfolk was formerly the great seat of hackneys, known as "Norfolk (trotting) Cobs." They are now scarce, and appear to be going out of fashion, or giving way to Norfolk farming. An historical sketch of these and other English-bred horses appeared in the Chester Report.

Agricultural Horses generally.

Class I.—*Aged Stallions for Agricultural Purposes.*—In this class we had 31 competitors. What an undertaking for the judges! They were first marshalled round a circle and drafted one by one until reduced to about 11 competitors; then commenced the arduous work of a close inspection; the action, form, quality, and general character, being the leading points that governed the decision. At length the first prize was awarded to a 4 years-old bay Lincolnshire horse, "Emperor," exhibited by Mr. J. Hemmant, of Thorney Fen, near Peterborough. This was indeed a valuable animal, and well calculated for his work, that of producing first-rate agricultural horses. He combined immense substance with elegance of movement upon short legs. The second prize was awarded to Mr. Clayden, of Linton, Cambridge, for his 4 years-old Suffolk horse, "Royal George." This was a good representative of the Suffolk breed; and singularly enough the third prize was awarded to a 3 years-old "Warwick and Suffolk" horse, the result of a first cross. Messrs. Edward and Matthew Reed's "England's Glory," of the Lincolnshire breed, was highly commended. This horse, owing to his age (3 years-old), was not sufficiently up in his form to compete with older horses, but will be seen to advantage another day. Messrs. Lowe's grey horse, "Grand Duke," and T. Crisp's Suffolk horse, "Marquis," were commended. There were other exceedingly good horses in this class.

Class II.—*Two years-old entire Colts:* 15 entries.—This was by no means a good class if we except the two prize horses. Mr. Holland, of Dumbleton Hall, Evesham, received the first prize for an excellent stamp of bay horse, powerful, good-looking, and

well up to the requirements of an agricultural horse. The second prize went to a Suffolk horse, the property of Mr. Wrinch, Ipswich. This was a useful horse, but scarcely up to the real standard of an agricultural horse.

CLASS III.—*Mares and Foals:* 20 competitors.—This was a pretty good class, and contained some bold specimens of a cart-horse. Both prizes were carried off by Suffolks, and a third Suffolk was commended. The Suffolk mares represented a greater uniformity of character and general outline than the bay and black breeds. The latter appeared overgrown for the class, in fact more suitable for the production of dray horses than those for agricultural purposes. The first prize was awarded to Mr. C. Frost, Ipswich, the second to Mr. G. D. Badham, Sudbury. Mr. Barthropp's mare was commended.

CLASS IV.—*Two years-old Fillies:* 13 entries.—Here again the first prize was awarded to a Suffolk filly, the property of Mr. Wrinch, while the second prize was carried off by a Clydesdale, the property of H.R.H. the Prince Consort. These were two beautiful animals, and well worthy of their distinction. The remaining fillies called for no commendation from the judges.

DRAY HORSES.

CLASS I.—*Aged Stallions:* 18 competitors.—This was an excellent class of substantial horses; the first prize horse, "England's Glory," was bred in Lincolnshire, and is now the property of Mr. B. Taylor, of Peterborough. He had long been noticed, especially in his own district, as a first-rate stamp of cart-horse; he is a good bay, with muscular limbs, robust carcase, and fashionable action. The second prize was awarded to a near neighbour of Mr. Taylor's, Mr. Hemmant, of Thorney, Peterborough (the owner of the prize horse for agricultural purposes). This again was a substantial bay horse of considerable notoriety and standing. There were a few more good-looking animals, but the judges did not recognize them as calling for especial commendation.

CLASS II.—*Two years-old entire Colts:* 6 entries.—Mr. Hibbard, of Bishopstone, Faringdon, received the first prize for a very promising brown horse, and the second was awarded to Mr. Buller, Banbury, for a roan colt bred by Mr. Root, of Edgcott Lodge, Banbury. Mr. J. Manning's (of Orlingbury, Northamptonshire) grey horse was commended. Beyond this the animals were of a moderate order.

CLASS III.—*Mares and Foals:* 6 entries.—These were below the standard of excellence required at such a gathering, and only one prize was awarded, viz., to Mr. W. Lowrie, Cadoxton, Cardiff.

This was a first-class brown mare, and highly deserving of the prize.

CLASS IV.—*Two years-old Fillies:* 3 competitors.—This was a moderate lot, and only one prize awarded—more by courtesy than merit. These animals should represent muscular power, massive frames, and sterling qualities, for the production of a *dray horse*, and not the active cast of those for agricultural purposes.

OTHER HORSES.

CLASS I.—*Thoroughbred Stallions for getting Hunters.*—This class, contrary to former years, brought together a good description of horse, in fact far better than the Society could have anticipated, considering the time they have to be on duty, and the draughts, &c., they are naturally exposed to. "Hunting Horn," the property of Mr. John Wadlow, of Shiffnal, was justly placed first, and "Sir Peter Laurie," the property of Mr. W. Barnett, near Cheltenham, second. "Hunting Horn" has immense size and substance, and must prove a most valuable horse for the purposes of producing hunters. "Sir Peter Laurie" is by no means a large horse, but very gallant and good. "The Ugly Buck" has scarcely substance enough for the Society's purpose, still, for years gone by, he has been known as a good getter. The remaining horses had no distinctive merit to call for a report.

CLASS II.—*Brood Mares for breeding Hunters:* 15 competitors.—In this class we had a sad mixture of animals for the purposes of breeding hunters; some good, some small, and some inferior; none but the real animal can possibly breed a weight-carrying hunter. Mr. J. K. Fowler, of Prebendal Farm, Aylesbury, exhibited a first-class bay mare, well up to weight, with beautiful form and action, in fact just the animal to breed a hunter. The judges at once selected her for the first prize, but from her having lost an eye, while the other appeared doubtful, it was decided to pass this mare by. The first award then fell to Mr. C. A. Holland, Hartford Hill, Northwich, and the second to Mr. W. Shaw, Far Coton, Northampton. The judges made no further selection in this class, neither could they well do so.

CLASS III.—*Brood Mares for breeding Hackneys:* 12 competitors.—This was a mixed class of mares. With one or two exceptions, they were by no means what they ought to be for the purposes of breeding hackneys; such a mare should combine the high qualities of a thorough-bred, upon short-jointed legs, with oblique shoulders, light head and neck, muscular points throughout; her every movement being that of an elegant hack. This stamp of animal was represented by the prize mare, the property of Mr. Coleman, Kingsbury Hall, near Tamworth. The

second mare, belonging to Mr. S. Wallis, of Barton Seagrave, Northampton, was a useful animal, but rather too small. There were no commendations in this class.

Pigs.

Of these there are several species. The domestic hog of England is clearly descended from the wild races, and has been transformed in several points by propagation according to fancy and local uses, resulting in our present established breeds. These still require further classification, for we have no animal more subject to the influence of original form than well-bred swine; neither have we an animal more susceptible of improvement. The hog in British farming is in general viewed as a subordinate species of live stock, and valuable chiefly as consuming what would otherwise be lost. But there are farmers who keep large herds to advantage. To the miller, brewer, distiller, and dairyman, they are an object of some importance and return. For the offal which they consume, they produce a greater weight of meat than could be attained from cattle. The prolific nature of this animal, however, rendering it easy to increase the supply above the demand, the price of pork varies more than that of any other sort of meat. Our native hog has been remodelled by the introduction of the small Chinese and Neapolitan pigs; the Chinese white pig giving the start to the small white races, and the Neapolitan to the small black breeds. Berkshire has long been famous for its breeds of the middle-sized black and white pigs; Essex for its black pigs; Suffolk for its white pigs; and the north of England for its large white bacon hogs: hence, it has been the object of the Society to encourage two descriptions of pigs, the one (small breed) more particularly for the production of *pork*, the other (large breed) for that of *bacon*. But, with such an undefined line between them, it is truly difficult to decide where the size of the small breed ends and that of the large breed begins. In thus classing the pigs many a useful animal is placed in the intermediate space. Take, for instance, the Berkshire pig, about the most serviceable and useful swine we have—a pig of ancient origin, and brought into notice by the Society's meetings. Thus, while the dairyman prides himself on his symmetrical blacks or whites for porkers, and the north countryman extols his large hogs for bacon, the Berkshire pig may be truly designated the "general purpose pig." Being very hardy, they are well adapted for the strawyard; they are also good graziers during the summer months, and possess more lean meat

than the smaller breeds. They are mostly bred in Berkshire and Oxfordshire. The pigs exhibited by Mr. Hewer, of Sevenhampton, were excellent specimens of the breed: his prize boar and prize sow at Warwick, his prize sow at Salisbury, and prize boar at Chelmsford, each gave striking evidence of the capabilities of the breed. Mr. Sadler, near Cricklade; Mr. Bowly, of Cirencester; and Mr. Joseph Smith, of Henley-in-Arden, are also amongst the leading breeders of this class of pigs, and have amply distinguished themselves. The preceding difficulty of classification has been subsequently entertained by the Council, and resulted in a modification of these classes, whereby each class or breed will contest against his fellow breed or similar description of pig. The four classes for the year 1860 run thus:—1. Large breeds; 2. Small white; 3. Small black; 4. Pigs of any colour not eligible for the other classes.

The three classes of pigs, those of the *Large Breed*—viz. for boars, sows, and pens of three breeding sow-pigs—contained respectively 13, 15, and 9 entries; total, 37. In the small breed classes the numbers were, 19, 47, and 3; total, 69. In the class for large boars, the prize was awarded to the large white sort, a boar, the property of Mr. J. Harrison, jun., near Stockport; the second to a young Berkshire pig of smaller dimensions; and the third to a Yorkshire pig, which had every evidence of a cross with the small breed. A Leicestershire pig was highly commended. This summary indicates the difficulty of classifying these animals, and thus much must depend in the award on the fancy or selection of the judges. They may one year prefer the large white, another year the Berkshires, and in a third an admixture between the large and small breeds.

The large breed sows, as a class, were not so good as we have seen them; their proportions were evidently reduced by crossing. Sir R. G. Throckmorton, Bart., exhibited a splendid Berkshire sow, which received the first prize. The second was awarded to Mr. Wainman's Yorkshire white sow; and the third to Mr. Woodcock's (Salisbury) Berkshire sow. In Class 5, for sow pigs of a large breed, the entries were chiefly confined to the midland counties, and the animals shown represented the Berkshire and other thick pigs. The long white pigs scarcely ever appear as young animals.

The prize pen of three black and white pigs, termed the "improved Chilton," were much admired; they were the property of Mr. Morland, of Chilton Farm, near Harwell, Berkshire: the second prize was awarded to Mr. Sadler, near Cricklade, for his pen of Berkshire sows. Mr. W. Hewer's and Mr. Bowly's pigs were very properly highly commended.

The Small Breeds.—These, as usual, were "the pets" of the show; there they lay, like a number of balls, perfect models of fat, but of their lean meat we must say but little; scarcely a pig amongst them could walk to his trough. Amongst the boars, we had a choice white specimen from the Prince Consort's stock—an animal well worthy of his first prize distinction. The second prize was awarded to Mr. Harrison, near Stockport; and the third to Mr. Holdway, of Weston, near Bath. The class was generally commended.

The small breed sows were both numerous (47) and good. In fact, it must have been a work of time and acute judgment to distinguish their qualities. Mr. Crisp, of Butley Abbey, exhibited four black sows, two of which received respectively the first and third prizes. A very beautiful black sow of Mr. G. Turner's, of Barton, Exeter, divided them by taking the second prize. This class was generally highly commended by the judges. The young sows were few in number, there being only three competitors. These were good ones. H.R.H. the Prince Consort received the first prize; Mr. Watson, of Bolton Park, Wigton, the second; and Mr. S. Wiley's (of Brandsby) was commended.

Cattle best adapted for Dairy purposes.—A local prize has for its object local good, hence the condition "best adapted for dairy purposes." This distinction is well meant, but it proved to be a "distinction without a difference." In these classes were animals of every breed and pedigree, from the best short-horns, Herefords, Ayrshires, &c., down to the humble yet respectable real dairy cow. There were collectively 77 animals entered in the four classes, viz. 11 bulls, 17 pairs of cows, 8 pairs of heifers in-milk or in-calf, and 8 pairs of yearling heifers. The bulls consisted of 10 short-horns and 1 Hereford. Mr. Ambler, of Watkinson Hall, near Halifax, exhibited a very beautiful 15 months old young bull, "Royal Turk," by "Heart of Oak" (14,683), in this class, and easily carried away the prize. This animal was decidedly one of the best short-horns in the yard—a remark which is substantially supported by the fact of his having been sold in the yard to Mr. Langston for 400*l.* He is a beautiful light roan, full of flesh, with first-rate form and quality. This bull will be seen again at future exhibitions, when we doubt not but that he will prove himself a distinguished competitor. The second prize was awarded to Mr. Farnworth, Cheshire, for a 16 months old roan bull; and the third to Lord Feversham, of Duncombe Park, for his Lordship's 17 months old roan bull by "Fifth Duke of Oxford," dam "Varna," by "Usurer." Mr. J. Heaword's bull was highly commended; and Nos. 925 and 927 were commended.

Class II.—*Milking Cows.*—This was an excellent lot of animals, but it more properly represented the "established breeds" than that for "dairy purposes," as the following awards and names of exhibitors will testify. Mr. Langston, 1st; Colonel Pennant, 2nd; E. Lythall (breeder of the first prize aged bull), 3rd; Henry Ambler and Joshua Price, highly commended; E. Bowly and H. Rawlings, commended. The first prize cow was a first-rate short-horn, suitable for any class, as were also nearly all the animals in this "Milking Class." It was thought by the Committee that this class would have proved a leading feature of the show, by pointing out the fine features and essentials of a dairy cow, best adapted to milking purposes. As a specimen of what a dairy cow ought to be, we at once point to a cow (No. 951) exhibited by Mr. Stead, of Owlerton, near Sheffield. This cow was apparently a cross between the Yorkshire dairy cow and Durham bull.

Class III.—*Heifers in Calf or Milk.*—The first prize was awarded to two roan Durham heifers, which represented everything good but milking qualities; they were the property of Mr. Joshua Price, near Wolverhampton. Mr. Hutt, of Water Eaton, near Oxford, received the second for a pair of capital heifers, which did represent the essentials of apparent milking qualities. The third prize was awarded to a pair of roan heifers, exhibited by Mr. J. K. Tombs, of Langford, Gloucestershire; these were very promising heifers. There were also four other entries noticed by the judges, two being highly commended, and two commended.

Class IV.—*Yearling Heifers.*—There were again in this class some first-rate specimens of the "established" short-horn breed: so much so, that the best pair of heifers, exhibited by Mr. Ambler, of Watkinson Hall, were selected by some Australian breeders for exportation, and were sold for 250*l.* These were, indeed, beautiful animals, especially the dark-roan heifer. The second laurel was gained by Colonel Pennant's pair of roan heifers; the third by Mr. Fletcher's, of Radmanthwaite, Notts, roan heifers, one of which, "Juliet," was a first-rate animal. Mr. Stratton's heifers were highly commended; Mr. Douglas, of Athelstaneford, exhibited a pair of red Ayrshire heifers, which, for uniformity of shape and promise of milking qualities, were highly approved by the dairy farmers. The first cross between the Alderney and short-horn bull is found to be especially good for dairy purposes, and is worthy of trial. The Alderney and Ayrshire also mix well for these purposes. The breeding of cows for "dairy purposes" is a subject that requires considerable forethought and practice. Dairy produce is now at its top figure; and as a com-

mercial eye is now being turned in that direction, the question need no longer be asked, Does a dairy pay? but rather, "What is a dairy cow?"

Cattle of the pure Long-horned Breed.—This truly local class of animals was well represented at Warwick, especially in the class for "pairs of cows." Here we had some *milking* cows; large and substantial animals, with every indication of being good at the pail. Cauley, in Warwickshire, has long been notorious for this celebrated class of cattle; still their centre seems to have been about the point where the counties of Warwick, Derby, Stafford, and Leicester approach each other. History points to Lancashire as having given the late Mr. Robert Bakewell a start in the production of his herd of long-horns; but it is well known that his best-bred animals came from the herd of Mr. Webster, of Cauley, in Warwickshire. His first cows, it is believed, were artfully obtained from Mr. Webster, of Cauley; and his famous bull "Twopenny" was bred from one of these cows. From these beginnings, with great judgment and attention, in a short time he reared some beautiful cattle: they were long and fine in the horn, had small heads, clean throats, straight backs, wide quarters, but were light in their carcase and offals, gentle and quiet in their tempers, grew fat with a small proportion of food; but these *fattening* animals gave less milk than some other breeds. It is to be regretted that we have no authentic record of his progress with these animals. No man perhaps ever made more comparisons between the different breeds of cattle than Bakewell, and no one that was able to tell us so much has told us so little about them. The late Mr. Lee, who was so successful a long-horned breeder, also resided at Cauley, where many breeders from different parts came to purchase bulls. Many of these went to Ireland. The neighbourhood of Normanton, Hinckley, Atherstone, Dishley, &c., in Leicestershire, were famous for these animals. Large and splendid dairies of them were to be seen in succession; but, alas! with the decease of the late Mr. Bakewell and other important supporters of the breed, they appear to have degenerated both in numbers and comparative standing. As competitors in our show-yards they number but few, yet it has been our province to have occasionally noticed some really good animals. As regards their uses they are classed as the most useful for dairy purposes, giving a great deal of milk of very good quality. Their frames have degenerated of late; they are now firm in flesh, with great hides upon them, which makes them more selling than formerly, hides being now $6\frac{1}{2}d.$ per lb. As fat animals, they are rather light in their fore-quarters, but good-constitutioned beasts, and endure hardships better than the short-horn, Hereford, or Devon. They carry but

little internal fat; when cut up the carcase is found to be very fleshy, not being the best-looking beef on the butcher's stall. In reply to my question at Warwick, "How is it that you have lost your size in the long-horn?" I received a capital retort, viz., "How is it that you have lost your size in Leicester sheep? we can still make 5 cwt. of cheese per cow from a 20-cow dairy, while your Leicester ewes refuse to raise their lambs." I moved on to the next class. The subsequent review of the classes will best illustrate the names of the competitors.

CLASS V.—*Bulls of any age.*—There were six competitors, all of whom resided in the county of Warwick. These were chiefly of the old dark brindled breed; they collectively formed a singular contrast to the "other breeds" around them. The first and second prize bulls were of large dimensions, but beyond this they did not call for any special commendation. The prize bull was exhibited by Mr. Burbery, of the Chase, near Kenilworth, who is now one of the leading breeders of the district. The second was awarded to Mr. Taverner, of Upton, Nuneaton. Mr. Hawke's 2 years and 1 month-old bull was commended.

CLASS VI.—*Pairs of Cows:* 6 entries.—This was an interesting class, and brought together a fair sample of the long-horned milking-cow. Five out of the six pairs were noticed by the judges. The prize cows exhibited by Lieutenant-Colonel Inge, of Thorpe Constantine, Tamworth, and the second prize cows shown by Mr. John Godfrey, of Wigston Parva, Nuneaton, were especially good. These cows combined every essential; they were truly majestic in their carriage, with small heads and peculiarly fine horns, fine coats, and small offal. They were much noticed by the public. Mr. Twycross, of Cauley, near Coventry, exhibited a pair of splendid cows, which were very properly highly commended. A second cow, the property of Mr. Twycross, was commended; as were also Mr. J. H. Burbery's cows. The prizes given in these classes were well directed by the local committee, and so were the open classes for "dairy purposes." But the result of the latter classes clearly shows that in all future cases where local premiums are offered for "dairy purposes" the wording of the classes must be more comprehensive and the instructions to the judges more binding. These premiums in the Warwick award were clearly thrown away, *i. e.* they were not given to the class of animals intended by the local committee to receive them.

HORSES.—With a view to local good, six special classes were opened for horses, viz., four for agricultural purposes, one for hunting-horses, and one for entire ponies. In the four agricultural classes we had 8 entries for aged stallions, 3 for young entire horses, 6 pairs of farm-horses, and 5 yearlings. There

were 24 hunters entered and 10 entire ponies, or collectively 62 animals. Mr. Manning's (Arlingbury, Northampton) horse "Sampson," winner of the first prize for agricultural stallions, was a splendid animal; his uniformity of carcase, power, and size, with great activity of action, caused him to be constantly admired by the public. The second prize horse in this class, the property of Mr. Robert Spencer, of Shuckburgh Lodge, Daventry, was also an excellent animal. There were three others commended in this class, viz., Mr. J. Morrell's brown horse "Champion," Mr. T. Baldwin's grey horse, and Mr. J. Ball's bay horse. The three horses shown in Class II. for young entire horses were each noticed by the judges: Mr. W. Buller's (Banbury) black horse "The Conqueror" was first; Mr. Thomas Crisp's, Butley Abbey, Suffolk, second; and Mr. W. Wynn's (Alcester) brown horse, commended. The class for the best pair of agricultural horses brought together some of the best animals we have ever had the chance to witness at an agricultural gathering. These consisted of six pairs. The first prize was awarded to a pair of 3 year-old fillies, the property of Mr. J. G. Attwater, Hallingwood Farm, Cubberley, Cheltenham. These were of the substantial yet active class of brown horse, peculiar to the Midland counties; their form, style, and substance confirmed the high estimation in which this class of agricultural horse is held by the public. A close contest ensued for the second place; at length the award fell upon Mr. J. Beasley's (Chapel Brampton) pair of Suffolk horses, bred by himself. These were of full size, active in their movements, deep in the carcase, and exceedingly good-looking for every-day work. The close opponents, a pair of black horses, the property of Messrs. Robinson, 15, Charlotte Street, Leamington, were excellent specimens of the active class of black horse. These were highly commended by the judges: Messrs. Robinson would say "deservedly so," and so did the public. Mr. J. Dormer, of Ashow, Kenilworth, received a commendation for his pair of horses—a bay and a roan.

CLASS IV.—*Yearling Colts or Fillies*: 5 entries.—These were of moderate order. The judges awarded the prize to Mr. Lowrie, Cadoxton, Cardiff, for his bay filly, without commendation to any other.

CLASS V.—*Hunting-horses*: 24 entries.—To show the judges' estimation of these, I may mention that they commended the class generally; and well they might,—they were a good lot. The first prize was awarded to a large and powerful horse by "Drayton," dam by "Steamer." This horse when placed before the judges displayed good style and action; he has immense bone and flat legs. The second award went to Lord Berners' bay mare "Barbara," a known good one. She was bred by his Lord-

ship by "Sportsman," her dam by "Reubens." A 4-year-old brown horse, the property of Mr. Booth, Killerby, Catterick, was highly commended; he is a clever and promising horse by "Barnton," his dam by "Pontifex." Mr. J. Arkwright's 4-year-old brown horse, and Mr. Formby's bay, by "Pollard," were commended by the judges.

Class VI.—*Entire Ponies:* 10 entries.—This class was an interesting one, and called forth much attention and admiration from the public. They were by no means an even lot, although collectively they formed a picturesque group of animals. The class was generally commended by the judges. From the disparity of size (from a wiry 14-hands pony to a 12-hands picture), some difficulty arose in making the award; at length the first prize was given to Sir Pyers Mostyn's (Talacre, Flintshire) 11-year-old bay pony "Young Bantam." Although within the limits of the class, he was thought to be rather beyond its intention both in shape and character of animal; his action was very showy, which went far towards securing him his high position. The second prize was awarded to a full-sized Welsh pony, the property of Mr. J. C. Wall, Redland Lodge, Bristol: this pony has immense power, but his colour is by no means in his favour. The judges highly commended Mr. Sullivan's, of Dublin, dark dapple bay pony, and Mr. J. C. Wall's 12-hands brown pony "Cadwaller." The first of these (Mr. Sullivan's) was truly beautiful in breeding and action, but rather too light as an entire animal. Not so with "Cadwaller;" he has breeding, with great power for his inches. Nothing could touch this pony for symmetry and quality combined; he is perfection in miniature. The Society would gain immense favour with the public were they to offer prizes for pony stock—"mountain produce."

Shropshire Sheep.—This breed of sheep, although practised upon to some extent to test the effect of certain crosses with the Down (which the breeders strongly affirm resulted in injury to the original sheep), has at length reached the high position of being admitted into the Society's prize sheet and showyard as one of England's "established breeds of sheep." Like the Berkshire pigs, they have been steadily gaining ground as middle-class animals. These sheep are of ancient origin, and previously to their subsequent cultivation for the better purposes of agriculture, were treated as hardy indigenous animals for the sheep-walks of the district, while the then more popular Leicester had many firm supporters for the enclosed lands. With the introduction of root cultivation it became necessary to increase the flocks, and, as a convenience, these hitherto hardy "hill sheep" were resorted to; as a natural consequence, they became rapidly developed in form, growth of wool and mutton,

which surprised their patrons. These improved animals were quickly noticed at the local fairs, and subsequently much sought after, especially the ewe stock, which was found to be more prolific than the Leicester, and this valuable property has not deserted them, as evidenced by the award of premiums to shepherds at the late agricultural meeting, the first winner having reared on the 1st of July 160 lambs from 100 Shropshire ewes. Such has been the rapid change in their favour, that a white-faced ram is now almost a rarity at the local fairs or markets. The Shrewsbury autumn fair is the great mart for their display, where considerable numbers of both rams and ewes are annually sold by auction. Some of the best sales average from 10*l.* to 16*l.* each, and in some instances 50*l.* to 60*l.* has been given for a single ram; the ewe stock of the general flocks are exceedingly hardy, and they continue to breed to a great age. The Shropshire fleece of wool is a good one, both as regards length, weight, and quality. The late Mr. J. C. Loudon, in his 'Encyclopædia of Agriculture,' at p. 1049 (when speaking of the numerous varieties of the British sheep), suggests as a convenience the classing them into divisions such as these: First, as to the length of their wool; secondly, as to the presence or absence of horns; and thirdly, as to original locality. The latter classification, he says, "might be made after the place or district in which such species are supposed to abound, to be in the greatest perfection, or to have *originated*." These suggestions have now received confirmation by the Society; we had first our long and short wool classes, we have now a third class recognized by *locality* as "the Shropshire sheep." The breed has been fostered year by year by practical men and breeders, who rested their claim to distinction solely upon the merits of their animals, and at length public opinion called forth a memorial on their behalf, and the Society has liberally granted the petition. In confirmation of the popularity of the breed I may mention that they are also supported by influential men at a distance, viz., in Staffordshire, by Messrs. Masfen, Coxen, Bird, Hon. R. Curzon, and Major Dyott; in Gloucestershire by E. Holland, Esq., M.P.; in Worcestershire by W. O. Foster, Esq., M.P.; in Warwickshire by Mr. T. Horley and Mrs. Baker; in Leicestershire by Mr. Pilgrim, and by Colonel Pennant in North Wales, Mr. Hamilton in Ireland, &c. On reference to the entries at Gloucester (their first great start), Chester, and Warwick, I find them steadily progressing:—at Gloucester they numbered, 121; at Chester, 184; at Warwick, 192.

In support of these remarks I now refer to the numerous entries for the local prizes offered for this class of sheep. The three classes brought together 125 specimens, viz., 43 shearling rams,

22 aged rams, and 12 pens of shearling ewes of 5 each; of these the judges especially noticed 7 of the shearling rams, and generally commended the aged ram and shearling ewe classes. These are striking illustrations in support of the late request for their being recognized as an "established breed."

Class I.—*Shearling Rams:* 43 entries.—The first prize was awarded to No. 1049, the property of Mr. John Coxon, of Freeford Farm, Lichfield. This was an excellent specimen of the breed, and the robustness of his form may be best illustrated by giving his girth, viz., 4 ft. 7 in. The second prize sheep, the property of Mr. Henry Sheldon, Brailes House, Shipston-on-Stour, girthed 4 ft. 3 in. The third prize was awarded to Mr. Thomas Horley, jun., of the Foss, Leamington. Messrs. James and Edward Crane's sheep, No. 1047, and Mr. J. Coxon's sheep, No. 1050, were highly commended. Mr. T. Mansell's and Mr. P. W. Bowen's were commended. It would indeed be improper to single out any special specimens beyond those noticed by the judges, but this much may be said of the class generally, that they were a first-rate lot of shearlings.

Class II.—*Aged Rams:* 22 entries.—This was indeed a splendid class of sheep, and went far to show the capabilities of the breed when fully developed. The prizes were awarded, first, to Mrs. Baker, of Grendon, Atherstone; the second to Messrs. J. and C. Crane, of Shrawardine; and the third to Mr. George Adney, Harley, near Much Wenlock. The judges also highly commended Mr. T. Horley's, Mr. J. Coxon's, and Mr. C. W. Thacker's sheep. The Earl of Dartmouth's, No. 1091, was commended; the class also was generally commended. The respective girths of the three winners stood thus: 5 ft., 5 ft. 3 in., and 4 ft. 10 in.

Class III.—*Pens of* 5 *Theaves:* 12 entries.—In this class we had again some capital animals; these prizes were more closely contested, and, as each sort had its admirers, they were constantly surrounded by the public. Mr. Holland's prize ewes were well up in their forms, but rather too weak (by comparison) in their necks. The Messrs. Crane's second prize theaves were truly beautiful; Mr. Horley's pen, No. 1112, was highly commended: these were excellent specimens. The class generally was commended by the judges.

Prizes offered for Berkshire Pigs.

Class I.—*Boars of any Age:* 14 competitors.—This class brought together specimens from eight of the principal breeders of this class of pig, and resulted in the class being generally highly commended by the judges; this commendation pronounces a high opinion upon the breed which the public appeared to

fully appreciate. Mr. William Hewer, of Sevenhampton, Highworth, received the first prize for his 1 year and 7 months old boar, by "Joshua," dam "Gipsy Maid;" the second prize went to Mr. Bowly, of Siddington House, Cirencester, for his 13-months-old pig, bred by himself.

CLASS II.—*Sows of any Age:* 17 entries.—All of which were generally highly commended by the judges. Mr. William Hewer here again maintained his high position, and received the first prize for his sow "Gipsy Child," by "Champion;" the second was awarded to Mr. Sadler, of Bentham Calcutt, Wilts.

CLASS III.—*Pens of 5 Breeding Sow Pigs:* 5 entries.—Both prizes were awarded to Mr. Jos. Smith, of Henley-in-Arden, Warwick. These were good specimens, and, as a proof of their excellence, they were quickly disposed of at high figures by private sale to breeders. Mr. William B. Wainman, of Carhead, York, received the prize for the pen of breeding pigs of a large sort; the Hon. Colonel Pennant, M.P., the first prize for the pen of sows of a small breed; and Mr. Watson, of Bolton Park, Wigton, Cumberland, the second prize. The class was generally commended.

Emmett's Grange, Exmoor.

XIX.—*On the Use of the Water-Drill.* By A. S. RUSTON.

AMONGST the many valuable inventions of the last few years, the water-drill occupies a deservedly prominent position, although its practical benefits are probably not so fully understood and appreciated as they merit; especially in some districts, where its value, more particularly in the production of green crops, has only to be tested to be proved. During the last half-dozen years, however, it has been making rapid progress, and has found its way into several new localities, in some of which it has effected great changes and completely revolutionized some of the old modes of cultivation; and there are instances in which its introduction and successful use have led to the adoption of entirely new rotations. On lands where, under the old systems of culture, great difficulty has been experienced in securing a regular and even plant and vigorous early growth, the water-drill has proved of incalculable service, by rendering a failure in this respect a very uncommon occurrence. This was a difficulty under which I laboured on my farms, and from which I suffered severely, until I used the water-drill. A full and even plant either of mangolds or coleseed, with a healthy

and rapid growth in the early stages, was seldom attained. The crop was almost invariably, either partially or wholly, destroyed by those numerous insect "pests" whose destructive energies are so commonly brought into active operation in such cases, occasioning grievous disappointment to the farmer as he witnesses the destruction of his hopes, and sustains the loss consequent upon the failure of his crop. And the loss of a green crop is not a matter of trivial importance, as it frequently implies injury to the succeeding cereal crop; and not uncommonly the whole rotation on that field is affected, causing heavy pecuniary loss. But since my adoption of this new method of sowing these crops I have scarcely ever sustained any such loss, but have almost uniformly succeeded in securing a full and even plant, with a free and vigorous early growth; so that what was formerly the rule has now become the exception, and *vice versâ.* But he must be a bold man, and a warm enthusiast indeed, who would venture to assert that the benefits accruing from the adoption of any principle, or the employment of any implement, on one peculiar description of soil, must of necessity equally result from its application to every other. Hence I would speak modestly with reference to the water-drill, and the benefits consequent upon its adoption. And although it has on my own farms and in my own immediate neighbourhood effected such important changes, and been attended with such successful results, yet I dare not affirm that equal success would of necessity attend its introduction under other circumstances and in different localities. Indeed, I have witnessed facts which go clearly to prove that this would not be the case. There are unquestionably certain peculiarities and varieties of soil where its use would be attended with positive mischief. And I would far rather admit and candidly acknowledge this to be so than seek in any way to cloak or deny it; I believe, however, that these are very exceptional cases, and require a good deal of searching to find them. I have met with one and only one such case, and that was upon the farm of Mr. Charles Howard, at Biddenham, near Bedford. Here, the superphosphate being sown with the water, and passing in this fluid form from the drill into the soil (which evidently possesses some peculiar chemical properties), appeared to form a sort of concrete, and made the land set and become unkind, which resulted in a very sickly and unhealthy growth of the plant. Doubtless there are a few other cases which in some respects may resemble this, but, from close observation and a rather extensive knowledge, I believe them to be very few indeed. Throughout this county, and also in some of the districts of Lincolnshire, where farming is so efficiently conducted, I have had opportunities of observing

carefully and critically the results consequent upon the adoption of this new principle of husbandry in the growth of mangolds, turnips, coleseed, and oats, and I unhesitatingly assert that it has proved a "perfect success." Similar testimony has also been borne by others, who with equal care have been watching its progress in other counties.

From these considerations, I conceive the water-drill evidently possesses claims which entitle it to be classed amongst the most valuable and successful inventions of the present day.

Mr. Chandler, a gentleman farming in Wiltshire, was the first inventor of the water-drill, and some years ago introduced it to public notice. He has, I believe, contributed a paper upon the subject, which appeared in an earlier number of this Journal. Since that time one or two other inventions, seeking to improve upon Mr. Chandler's principle, have been before the agricultural public, but have not come into general use. As my own experiments have all been made with Chandler's drills, and the observations I have made and the information I have acquired have all been in connection with them, I shall confine my remarks to this particular form of water-drill.

When Mr. Chandler first invented the drill he made it to discharge the liquid by means of cups affixed to endless chains, which were made to revolve by means of a spindle which passed through the cistern containing the liquid; but this principle was found to work imperfectly, as the chains soon got out of order, thus preventing that regularity of motion and proper delivery of the liquid which were requisite. These chains were consequently very soon abandoned, but the cups were retained, and a much-improved principle of working them was adopted. They were placed upon discs, like the cups of a seed-barrel, and like them revolved, but only in the manure-cistern instead of in the seed-box, discharging the liquid manure into pipes, which conveyed it through the coulters into the ground, precisely as the corn-barrel delivers the seed. This principle has been continued, and still remains in use. About five years ago Messrs. Reeves, the manufacturers of Chandler's drills, patented an entirely new method of discharging the liquid from these drills. This consisted of plates fixed at certain intervals in the bottom of the manure-cistern; these plates were perforated, and underneath them passed a slide which was worked by a handle at the side of the drill, and which regulated the quantity of liquid discharged from the cistern, by passing the slide under a part of the holes in the plates, thereby preventing any discharge from those holes so covered; so that when a larger quantity of liquid was required to be sown more of these holes were left unin-

fluenced by the slide, and when a smaller quantity was desired more of the holes were stopped by it; and at the ends of the field, to prevent any escape of the manure whilst turning and setting in again, the slide was made to pass under the entire of the plates, thereby preventing any discharge whatever. To prevent any particles or small unbroken lumps of manure getting into these holes in the plates, a cylinder with small steel stirrers revolves inside the cistern; these stirrers just pass over the plates, gently scraping them, thereby preventing any accumulation which might occasion a stoppage or interruption of the proper supply of liquid from the cistern. Both these principles of drill possess advantages and disadvantages which are worthy our attention, and which, as far as my own experience and observation enable me, I will attempt to point out. The drill made upon the cup principle is more easy of management, and requires less care in the preparation of the manure, than the other, and is consequently more largely adopted in those districts where used for green crops only. But where required for cereal crops, the cup drill is altogether inferior to the other. There is necessarily great difficulty in getting as large a number of these cups to work in the cistern as are required to supply with liquid the number of coulters generally used when sowing corn. But of course this objection only applies to those crops which are usually sown in rows not more than 8 or 10 inches apart. There is, however, one other objection to this cup principle, which is of more general application. When the drill turns round at each end of the field there is always a temporary pause before the horses start again, and during this momentary delay and want of motion in the drill the more solid parts of the manure—those least soluble—naturally settle and accumulate at the bottom of the cistern; and then, as the drill starts again, ere it gets into full motion and the liquid acquires one uniform consistency, the cups fill with this solid sediment, which, instead of discharging, they retain, until the more perfect motion of the drill washes it out and they commence a proper discharge, but this is not until the horses have moved some few yards; the consequence is, the ends of all the rows receive an inadequate supply of manure. This is a difficulty I have hitherto been unable to overcome, and is also one of some practical importance.

Messrs. Reeves' new principle, on the other hand, is better adapted for general purposes, as a larger number of coulters can be supplied with liquid, which is of very grave moment in this neighbourhood where the water-drill is so largely employed in the growth of cereal crops. It is also free from the objection

which exists against the other, and which I have just explained, viz. the irregular and deficient discharge of the manure at the ends of the field. Where properly and carefully managed, nothing can exceed the regularity with which it discharges the liquid. On one occasion I sowed 24 rows of coleseed in one field, and the same in another, by putting *the seed into the cistern*, and discharging it with the liquid through the plates at the bottom of the drill. In both instances I had an uniformly regular and even plant, as much so as if the seed had been deposited in the usual manner. This experiment clearly convinced me that from this drill, with right management, there must be a most satisfactory and equal distribution of the manure; and this is one of the advantages of the liquid system which should never be overlooked. With the dry drill it was quite impossible to get either superphosphate of lime or guano to run evenly: in spite of every effort, it would beat up into lumps like mortar or putty, and discharge itself with great irregularity, to which the crop bore unmistakeable testimony.

As I have already intimated, this kind of drill requires more careful management, and makes it necessary to send a better style of labourer with it, than would be required to work one on the cup principle. But, after all, it is more a question of careful attention and steadiness of management than of skill. The manure requires to be more finely sifted, and the slide needs constant vigilance and attention to keep the flow of the liquid uniformly regular. But this can be easily done, although in many instances it is shamefully neglected. Careless men, who shirk work, regardless of consequences, instead of seeing that the manure is finely sifted and equally distributed, very frequently allow it to be thrown in large unbroken lumps into the cistern, and with the same unconcern neglect the right management of the slide; the result is a very defective and irregular crop, one coulter having been almost stopped, whilst another has been discharging too freely, until at length, as the crop progresses, the whole field presents the aspect of a mass of irregular patches, whilst it occasions a heavy loss to the owner. But this need not be; and wherever witnessed, only goes to show that a most indolent and inattentive labourer has been employed.

It has, however, been adduced as an argument that, because the new principle of drill requires more care and attention than the old one, notwithstanding its many superior advantages when rightly managed, it ought to be abandoned; and the other, imperfect though it be, adopted. But I question this conclusion. If the one performs its work more advantageously in every

respect than the other, requiring only a more competent and skilful labourer to manage it, surely it becomes us rather to try and train up men to this standard of efficiency, than to seek to accommodate our implements and farm operations to their careless and slovenly habits, thereby putting a premium upon negligence and inefficiency. If ever we are to have intelligent and superior labourers, it must be by diligently training them to the right management of those useful inventions which the science of modern agriculture is so constantly urging upon our adoption.

As I have previously stated, the water-drill is not equally adapted for every peculiarity of soil and circumstance, although it would probably prove a decided acquisition to the great majority of English farmers. Soils vary considerably in the degree of their natural fertility. In one district we find that nearly every crop flourishes, whilst in another the very opposite is the case. Climate, too, exerts a very powerful and decided influence upon the cultivation of different localities. Where rain is more frequent and copious less difficulty is experienced in securing the successful growth of green crops than where drought prevails, although the latter is frequently more favourable to the growth of cereals. It is, therefore, in the eastern counties, and other districts of the country, where the amount of rainfall is considerably below the average, and where, consequently, greater difficulty is experienced in the successful culture of green crops, and also on soils that are naturally unkind and ill-adapted for the free vegetation and vigorous early growth of the young and tender plant, that the triumphs of the water-drill have been most signal. In this immediate locality we have to contend against both these evils. The climate is dry, and at times very withering, whilst the soil is fickle and generally unfavourable to the early growth of tender plants. This led me five years ago to hail the water-drill as a great boon, and to introduce it to this part of the country. Since then the results of its employment have been so eminently satisfactory, that its use has been very widely extended throughout the whole of the surrounding neighbourhood. In this parish alone I believe there are now not less than 12 or 14 water-drills, all of which find considerable employment during the times of the oat, mangold, and coleseed seeding.

The mode of working these drills is far less difficult than would be generally conceived. The main thing is the supply of water required, and, upon an occasional farm, this does grow into a slight difficulty. On our Fen-farms, where every field is surrounded by ditches, which throughout the entire year have a supply of water, this difficulty has no existence. And

upon what we technically term our *high* land farms, where hedges generally prevail, we have either open ponds and reservoirs, or pumps supplied by unfailing springs, where ample supplies of water can be procured. In cases like these we find it necessary to purchase either some old oil casks, or what is better, because stronger and more durable, some old sherry butts. These we fit up with a sort of hopper at the top, where the water is cast into them, and a leather hose at the end, where the water is discharged; this hose being made sufficiently long to admit of its being hung by a loop upon one end upon the top of the cask, when no discharge is required, by which means any improper escape of the water is avoided. These casks are placed in an ordinary dung-cart, and, to prevent any rolling motion, a little long soiled straw is placed on either side of them. This simple and inexpensive method, where proper water-casks, for other uses, are not required, answers every practical purpose. It very seldom happens that more than *two* of these casks are required to keep a drill fully at work. These will serve for a distance exceeding half a mile, and three would convey the full quantity of water required if the distance exceeded a mile. Where two only are required to be used one horse is ample, where three are needed two horses will be necessary. One cart containing the full cask may always be set down in the field where the drill is working, being careful to place it in such a position that it will not interrupt the drill in its work, but will, at the same time, be convenient for use. The hose is unfastened from the top of the cask, and that end of it is placed in the cistern of the drill, allowing the water to continue to run until a sufficient quantity has been obtained, when the hose is again fastened as before. Where water is procured from the ditches which surround the field in which the drill is at work, the method adopted is very simple indeed. A large tub is placed at the side of the ditch just where the drill turns out at the end; this tub is kept filled with water, the drill draws up by the side of it, and the men at once, with pails, fill the cistern.

I may here remark that it has not been my practice to sow any kind of liquid manure from tanks, such as urine or yard drainings, but simply water, in which I have placed either superphosphate of lime, guano, or a mixture of the two. My general practice is to use superphosphate alone, but in a few instances with oats grown upon wheat stubbles, I have thought it desirable to supply ammonia in some form to a moderate extent, and have consequently sown from 1 to 1½ cwt. Peruvian guano, mixed with 1 cwt. superphosphate, per acre. And when this has been done I have had the two mixed together and riddled in

some spare building, that the large hard lumps, which are generally found in considerable quantities in the guano, might be thoroughly broken and pulverised before going into the field. But where superphosphate alone is used this is altogether unnecessary. My plan then is, to take the bags of manure, just as they come from the manufacturer, into the field; a man then prepares it for use. He has a wheelbarrow and a fine sieve, with a shovel; he takes the manure from the bag with the shovel, places it in the sieve, and then sifts it into the wheelbarrow; the lumps which will not pass through the sieve he throws into a small tub taken to the field for that purpose; these he breaks until they are sufficiently small. I usually sow from 2 to 3 cwt. per acre, and with a 4 ft. 6-inch drill sow 7 acres per day. One man will sift all the manure, help to fill the drill with water, and, if in a field where the supply can be obtained from the ditches, will also keep the large tub filled with water. In such cases this single man is the only additional labour required by the water-drill over the dry, and, indeed, where that is used, some preparation of the manure is necessary. Where the water has to be conveyed a distance, as previously stated, an additional man with a horse will be required, and sometimes a boy also to pump.

The whole of the experiments I have yet made with the water-drill have been made with the one on the new principle, which I have already so fully described. Regarding it as the best for general purposes, and, where carefully and skillfully managed, the most equal distributor of the manure, I have been led to use it almost entirely, and the remarks I am about to make as to these experiments and the general working of the drill will be made with reference to this exclusively. Several modifications of this principle have been made by Messrs. Reeves, more especially as regards the discharge of the liquid through the plates, but I prefer the original plan, and still adhere to it; the only exception being, that I have shortened the length of the steel stirrers.

In sowing mangold, coleseed, or turnips (the last-named, however, are scarcely ever sown in this locality), I invariably use only two coulters, which, with a 4 ft. 6-inch drill, make the rows just 27 inches apart. Careful and close observation during the last five years has fully and thoroughly convinced me that this distance is in every respect better for either of these crops than three coulters 18 inches apart would be. The horse-hoe can be used freely and frequently, and a stronger and more vigorous plant secured. When sowing any crop, where only two coulters are employed, we use plates in the cistern for the discharge of the liquid, with holes punctured through them from one-half to

five-eighths of an inch in diameter; and with these a cistern full of water, which is about 60 gallons, will sow 40 chains, which will give a total of about 220 gallons per acre. With larger-sized holes an increased quantity of liquid could easily be sown, but experience does not prove that this would generally be of practical advantage. In sowing oats and other cereals, where it is found necessary to use the whole six coulters, a different plate should be used. This is of the utmost importance, although frequently neglected. The large holes in the plates just described allow of too rapid a flow of liquid where six coulters have to be supplied, and it frequently occurs that the drill becomes nearly emptied much before it ought to be, and, consequently, that those parts of the rows sown first, after the drill had been refilled, get a much larger share of manure than they ought to have; whilst the other ends of the rows, sown as the supply was becoming exhausted, get far too small a quantity, and hence you have a very uneven and irregular growth. It may, however, be easily obviated by using a different plate. The results of several trials made during the last few years on a somewhat extended scale, show that the plate best adapted for the successful working of six coulters is one with holes from three-eighths to five-sixteenths of an inch in diameter. With these we sow 60 gallons of water in about 30 chains, which will give a total quantity of nearly 300 gallons per acre. In sowing with six coulters it is very needful when the drill is full that the holes should not be *quite* opened, as the flow from the weight of liquid in the cistern is necessarily more rapid than when the quantity becomes lessened; this can be easily managed by the slide, but requires constant attention if the discharge throughout the whole length of the field is to be equal. It can be done, as was proved by my own crop of oats sown last spring. I put in 112 acres with the water-drill, the whole of which came up and grew as uniformly even and regular as could be desired. But, besides the equal distribution of the manure *from* the drill, there is also needed the equal and regular supply of it *to* the drill. This is managed by ascertaining in each field into which the drill enters how many rounds the drill must perform to sow an acre. Having calculated this, and knowing the number of half-pecks each bag of manure contains, it becomes an easy matter of calculation to learn how many half-pecks are required for each drillful of water. These are then properly measured and applied, and the object sought is attained.

For the first few years after my adoption of the water-drill principle, I sowed in every field of mangolds, or coleseed, a few

rows—generally eight—with the dry drill, using precisely the same quantity and quality of manure as was sown by the water-drill. Indeed it is only during the last two years that I have discontinued this practice. But the results were so uniformly the same that it ceased to be necessary longer to make these experiments. I should also add that to test the value of the artificial manure used, as well as the comparative merits of the two drills, I for the first year sowed in every field two or four rows without any manure, and in no instance saw cause to regret the judicious application of an artificial stimulant to green crops. In 1854, the first year after I had purchased a water-drill, I not only made the experiments between that and the dry drill just referred to, but also, as regards the mangold crop, carefully measured a portion of the field so sown, had the roots properly cleaned, and afterwards weighed, to ascertain exactly the relative merits and demerits of the two drills. The following Table will show the results:—

TABLE I.

Number of Experiment.	When Sown.	What Drill used.	Quantity and Description of Artificial Manure per Acre.	Cost per Acre of Artificial Manure.		Farm-yard Manure per Acre.	When Weighed.	Produce per Acre.			
				s.	d.			tons.	cwt.	st.	lbs.
1.	Apr. 1	Water drill	1¼ cwt. Lawes' superphosphate of lime	11	3	16 loads	Oct. 5	20	16	6	4
		Dry drill .	Ditto	11	3	16 loads		15	9	5	2
		Dry drill .	None	..		16 loads		13	13	4	8
2.	Apr. 3	Water drill	1¼ cwt. Lawes' superphosphate of lime	11	3	16 loads	Oct. 5	20	19	2	4
		Dry drill .	Ditto	11	3	16 loads		15	16	6	4
		Dry drill .	None	..		16 loads		15	0	0	0
3.	Apr. 17	Water drill	1 cwt. Lawes' superphosphate of lime	7	6	11 loads	Oct. 4	17	7	6	12
		Dry drill .	Ditto	7	6	11 loads		13	15	2	12
		Dry drill .	None	..		11 loads		8	15	0	0
4.	Apr. 5	Water drill	1¼ cwt. Lawes' superphosphate of lime	11	3	11 loads	Oct. 3	15	14	5	2
		Dry drill .	Ditto	11	3	11 loads		14	14	2	4
		Dry drill .	None	..		11 loads		11	17	4	0
5.	Apr. 18	Water drill	1 cwt. Lawes' superphosphate of lime	7	6	13 loads	Oct. 4	13	19	2	4
		Dry drill .	Ditto	7	6	13 loads		10	8	1	10
		Dry drill .	None	..		13 loads		6	18	4	8
6.	Apr. 4	Water drill	1¼ cwt. Lawes' superphosphate of lime	11	3	15 loads	Oct. 3	9	18	7	6
		Dry drill .	Ditto	11	3	15 loads		8	12	1	2
		Dry drill .	None	..		15 loads		6	10	0	0
7.	Apr. 20	Water drill	1 cwt. Lawes' superphosphate of lime	7	6	13 loads	Oct. 17	27	14	2	4

This was an unfavourable season for making these experiments. The exceedingly dry weather during the months of August

and September, just when the bulbs should have been daily gaining considerable weight, altogether impeded their growth, and in one or two instances almost imperilled their existence. For the drought was accompanied with intense heat, which exerted a destructive influence upon vegetation generally. Nos. 4, 5, and 6 were grown upon warm gravelly land, with a light blowing soil, and were consequently an almost perfect failure. Since these experiments were made I have altogether discontinued the cultivation of root-crops upon all such lands. Success could only be secured in a cool showery summer, succeeded by a fruitful and forcing autumn; the risk of a crop was, therefore, too great to warrant a further repetition of the attempt. In No. 7 the eight rows sown with the dry drill were a total failure—the whole of the plant was destroyed; whilst the remainder of the field, where the water-drill had been used, exhibited as even and regular a plant as could be desired. This is the best field for mangolds, *naturally*, of any on which these trials were made. From this Table it will be seen that the amount of artificial manure sown was very small, in three instances only 1 cwt. per acre, and yet the increase of crop where this small quantity was put on with the water-drill was very considerable. In one case—No. 3—the increase was over 3½ tons per acre, and in No. 5—one of the failing crops from heat and drought—the difference was about the same. In Nos. 1 and 2, which were less susceptible of atmospheric influence, and were consequently not so seriously affected by the drought and high temperature of the autumn months, we find 1½ cwt. of superphosphate, sown in a liquid form, produced upwards of 5 tons per acre more mangolds than the same quantity sown in a dry state. These experiments also reveal very clearly the benefits accruing from the use of artificial stimulants in the growth of root-crops. In Nos. 1 and 2, where 16 loads of good farmyard manure were put upon an acre, a heavy crop was not realized, but when 1½ cwt. of superphosphate of lime, at a cost of only 11*s.* 3*d.* per acre, was added, the crop was increased to the extent, in No. 1, of upwards of 7 tons, and, in No. 2, of nearly 6 tons per acre, whilst in No. 3, where only 11 loads of manure were put upon an acre, 1 cwt. of superphosphate, at a cost of 7*s.* 6*d.*, nearly doubled the produce. I should, however, observe that this large increase in the weight of roots per acre is not entirely owing to the increased size of the bulbs obtained by the use of the artificial manure and the water-drill, but partly, and in some instances largely, to the better and more perfect plant secured thereby: the one being uniformly even and regular, the other broken and patchy.

In the following year I made a precisely similar series of ex-

periments, only omitting to sow any rows without the artificial manure. These I have also tabulated:—

TABLE II.

Number of Experiment.	When Sown.	What Drill used.	Quantity and Description of Artificial Manure used.	Cost per Acre for Artificial Manure.	Farm-yard Manure per Acre.	When Weighed.	Produce per Acre.
				s. d.			tons. cwt. st. lbs.
1.	Apr. 26	Water drill	1½ cwt. Lawes' superphosphate of lime	11 3	13 loads	Oct. 16	18 2 4 0
		Dry drill .	Ditto	11 3	13 loads		8 10 5 10
2.	Apr. 26	Water drill	1½ cwt. Lawes' superphosphate of lime	11 3	13 loads	Oct. 16	19 2 6 12
		Dry drill .	Ditto	11 3	13 loads		13 15 0 0
3.	Apt. 25	Water drill	2 cwt. Lawes' superphosphate of lime	15 0	13 loads	Oct. 15	19 2 6 12
		Dry drill .	Ditto	15 0	13 loads		12 15 5 10
4.	Apr. 21	Water drill	1½ cwt. Lawes' superphosphate of lime	11 3	13 loads	Oct. 17	27 5 5 10
		Dry drill .	Ditto	11 3	13 loads		16 10 0 0
5.	Apr. 28	Water drill	1½ cwt. Lawes' superphosphate of lime	11 3	10 loads	Oct. 17	30 0 0 0
		Dry drill .	Ditto	11 3	10 loads		20 13 4 8

From the above Table it will be seen that the weight of roots per acre in Nos. 1, 2, and 3, from both drills, is considerably smaller than in Nos. 3 and 4. This is owing to the fact, that the former are all gravelly soils, and not exactly adapted to the growth of a heavy crop of mangolds, although they invariably produce a superior quality, whilst the latter are cool-bottomed and deep-soiled lands, well suited for the successful cultivation of this crop. These gravelly soils, just referred to, are of a very different quality to those specially named in the former Table. Instead of a light dusty soil, liable to blow with high westerly gales, they consist of good rich loam resting upon gravel, which unfortunately rises too near the surface, and consequently reduces the crop. Many of the remarks made with reference to Table No. 1 of a more general character are equally applicable to No. 2, and need not be repeated. It may, however, be observed that throughout these experiments the quantity of artificial manure is slightly increased as compared with the preceding year, the minimum being 1½ cwt. per acre, and the maximum 2 cwt. The results as to the produce are very similar, ranging from nearly 6 to over 10 tons per acre in favour of the water-drill. It cannot, therefore, be matter of surprise that these experiments, so carefully made for two successive years, should lead me publicly to advocate the claims of the water-drill system. Their success was so uniform and unvarying, and the results so eminently satis-

factory, that I cannot fail to regard them as worthy of an extended publicity.

In 1853 I was spending a few days in North Lincolnshire, and whilst there witnessed some experiments made in a field of turnips which, in some respects, resembled those made by myself during the two following years with mangolds. I give this case as it is one of considerable importance, and tends to elucidate the correctness of the water-drill principle as applied to a different crop, and on a soil widely varying in every respect from any of those already referred to. The experiment was made upon a field just skirting the Lincolnshire Wolds, forming a part of Mr. Francis Sowerby's Aylesby Farm. The particulars are tabulated below.

TABLE III.

No. of Experiment.	When Sown.	What Drill used.	Quantity and Description of Artificial Manure used.	Farmyard Manure per Acre.	When Weighed.	Produce per Acre.			
						tons.	cwt.	st.	lbs.
1.	June 17	Water drill	2 cwt. guano, and 2 bush. dissolved bones .	10 loads	Nov. 15	23	0	0	0
2.	June 17	Water drill	2 bush. dissolved bones .	10 loads	Nov. 15	22	15	0	0
3.	June 18	Dry drill .	6 bush. bones, and 12 bush. ashes	10 loads	Nov. 15	17	1	0	0
4.	June 24	Water drill	2 bush. dissolved bones .	None	Nov. 15	18	15	0	0

From the above table it will be seen that 2 bushels of dissolved bones sown with the water-drill produced 5 tons 14 cwts. more turnips per acre than did 6 bushels of bones mixed with 12 bushels of ashes, and sown with the dry drill, all other things being equal. It also shows that 2 bushels of dissolved bones sown with the water-drill, and without farmyard manure, produced 1 ton 14 cwt. greater weight of turnips per acre than 6 bushels of bones and 12 bushels of ashes with 10 loads of manure per acre added. These are important and telling facts, but there is one other which appears even more remarkable still. I refer to the fact that 2 cwt. of Peruvian guano only gave an increase of 5 cwt. of turnips per acre, as shown in Nos. 1 and 2, all other things being equal. These turnips were sown upon ridges, the manure being spread down the rows, and the guano sown dry upon it, were covered in in the usual way with the plough, and the seed was then drilled with the application of the dissolved bones and the water. Since these experiments were made I believe Mr. Sowerby has discontinued the practice of dissolving the bones for his own use, as it was attended with considerable trouble and inconvenience, and with no direct practical benefit, as

was clearly ascertained by testing these side by side with Lawes' superphosphate. The result is that Mr. Sowerby now uses this manure exclusively. Since 1855 I have continued to make experiments similar to those recorded in Table No. II. until the last two years. Every year the results were so palpable and unmistakeable that I considered it unnecessary longer to weigh the crops. The relative proportions have been uniformly maintained, and the table for 1855 would almost do for either 1856 or 1857, except that some of the crops during the latter years have been altogether heavier; but this has not altered the relative position of the two drills. This increase may perhaps to some extent be attributable to the alterations I have made in my system of manuring. Instead of using 13 and 15 loads of farmyard manure per acre, as shown in Tables I. and II., I now use only 8 or 10, but apply an increased quantity of superphosphate, my minimum now being 2 cwt., and the maximum 3 cwt. This year and last, instead of sowing mangolds in one continuous row with the old coulters, I have used the drop coulters invented by Mr. Chambers and supplied to me by Messrs. Reeves. These dropped the seeds in clusters about every 14 inches, leaving the manure immediately under them. In both years I have been very successful. There are evidently some advantages in having a *thick* plant of mangolds when they first come up; they appear less liable to be injured by insects, and generally grow faster and stronger. The manure also being so immediately under the plant, when it has been properly singled and thinned, must stimulate a quicker and secure a larger growth of the bulb. Experience confirms the correctness of these theories.

The same experiments which were made, as shown by the tables, with mangolds were also made annually with coleseed, and with even more satisfactory results. In each field the trial was repeated; and during the four years the increased produce resulting from the use of the water-drill was from 30 to 50 per cent. Failure was of rare occurrence with the one drill, but very common with the other. This crop cannot be tested by the weighing machine, but I believe I have not at all exaggerated or overstated the case. Coleseed is a crop very largely grown throughout the whole level of the Fens, and is now commonly taken as the fallow crop, which, like the turnip crop in other districts, must be regarded as the basis of a good system of culture—its success or failure almost invariably affecting the whole of the succeeding rotation. It therefore behoves the fen farmer to give all diligence and to exert his best energies to secure the successful cultivation of this crop. Perhaps no agent has rendered him such essential service in the realisation of this important object as the water-drill, especially upon those weak

and inferior soils where failure was frequent, and where success was supremely needed; for it is difficult to estimate accurately the benefit which accrues to such soils from having a full and heavy crop of coleseed, with some cake or corn consumed upon them. The results upon succeeding crops are most palpable and unmistakeable.

During the last two years I have sown all my oats with the water-drill. Where these crops have been sown upon land where coleseed had just been eaten, and which was in thoroughly good condition, I have applied 2 cwt. per acre of Lawes' superphosphate of lime, last year at a cost of 15*s.*, and this year, from the reduction in the price, at a cost of 13*s.* 6*d.* In one or two instances, where the oats were sown upon wheat stubbles, I have this year applied 1 cwt. of Peruvian guano and 1 cwt. of superphosphate, properly mixed, per acre, at a total cost of 1*l.* 0*s.* 3*d.* The results have been eminently satisfactory; and, had I contemplated writing this paper, I would have made some careful experiments to show the precise amount of benefit derived by this crop from the use of the water-drill. But although I have failed to do this, I can nevertheless record my convictions, arrived at by a most vigilant attention to the crops whilst growing, and to their appearance at the time of harvest. With the oat crop my experiments were somewhat different from those made with the green crops, my object being rather to ascertain the amount of benefit to be derived from the use of superphosphate applied in a liquid form by the water-drill, than to test the comparative merits of the two drills. I therefore in every field—as near the middle of it as I could—left one width of the drill without any manure. These six rows I continued to notice at different intervals throughout the whole of the summer. When they first came up only a slight difference was perceptible, but as they commenced growing the difference became more distinct, until they reached the "weaning time," when those without manure assumed a weak and sickly appearance, whilst the others were scarcely checked in their growth, and where the land was free from wireworms made rapid and surprising progress, which made the unhealthiness of the six rows increasingly visible. For my own information, and to aid me in deciding upon my future course with reference to the growth of oats, I attempted at harvest to estimate the difference in the produce of the crop, which I placed at 3 quarters per acre in two or three different cases. My readers will be prepared, therefore, to receive the statement that it is my intention to continue the use of the water-drill and superphosphate for this crop. I may here remark that three of these fields, of 14 acres,

16 acres, and 20 acres respectively, were lands which, previously to the introduction of the water-drill, would scarcely grow oats at all, and consequently they were seldom or never sown. On two or three different occasions when I had made the attempt a crop of about 5 quarters per acre was the result; whereas this year, with the water-drill, I believe I have, in two out of the three fields just named, from 8 to 9 quarters per acre. These fields consist of a light and rather dusty soil, with the gravel near the surface, and in dry seasons grow a very small bulk of straw. The water-drill meets this difficulty. On these soils it has enabled me to change my rotation, and to adopt a five-course shift of coleseed, oats, wheat, seeds, wheat; whereas formerly I could only grow wheat after the coleseed, and was consequently driven to fallow every four years upon land which did not otherwise need it, and was also subjected to the inconvenience and loss occasioned by being compelled to eat off all my coleseed before the end of October—wheat on these soils universally failing if sown later.

I now grow my coleseed and oat crops on these lands exclusively with the water-drill and artificial manure, reserving the whole of the farmyard manure for the wheat crops, and the system appears to succeed well. I should observe that in feeding off these coleseeds I always give the sheep either linseed or cotton-seed cake, or some kind of corn.

This year I have sown 24 acres of peas with the water-drill; and from the growth of the crop through all its stages infer that it will be found practically advantageous to use it for this description of crop also.

Last spring I sowed 2 acres of carrots with the drill, using 6 coulters and putting on 2 cwt. of superphosphate per acre. The crop was an excellent one, estimated by competent judges at over 25 tons per acre, and I think fully this quantity was realised, for I had 50 large loads—as much as two horses in a cart could pull out of the field.

When the water-drill was first introduced, and its influence upon the early growth of green crops was recognized, it was thought and said by many, that this excessive growth would not be continued, but that the manure would soon become exhausted; and that the plant, when approaching maturity, and most in need of sustenance and support, would fall short of nourishment, and evince symptoms of premature decline and decay. But in my own experience these theories, prompted by fear and founded upon mere surmise, have not in any one instance been confirmed by fact. A reference to either of the foregoing tables will clearly show that the rapid progress made in the early

growth of the crops was fully maintained to the end. Take the case in Table III., where 2 bushels of dissolved bones, without any kind or form of manure, sown with the water-drill, yielded a heavier crop of turnips than 10 loads of farmyard manure, 6 bushels of bones, and 12 bushels of ashes, unitedly produced. This surely must be conclusive upon this point, and the more so when corroborated by the testimony of one's own experience year by year.

Why it is that such marvellous results, on some soils especially, should accompany the use of the water-drill and superphosphate of lime, belongs rather to the chemist than the practical farmer to explain. It appears pretty certain, however, that the action of the water upon the soluble portions of the manure is such that healthy food is made immediately available to the plant, whilst the less easily soluble portions are slowly and gradually decomposing in the soil, yielding the support required by the plant as it continues to progress, and, as the experiments show, not failing it until its full growth has been attained. I have also further learned from experience that the manure sown in this liquid form is not only beneficial and influential upon the early growth of plants when applied to lands where drought or a deficiency of moisture prevails, but also upon lands which are in a satisfactory condition as regards moisture. On one or two occasions I sowed lands with coleseed which were too wet to roll, and when the horses had to be taken out in consequence; *and yet the difference between the crops where the manure was sown with the water-drill and where applied with the dry drill was as apparent and as marked as in any other cases where the lands were in a totally opposite condition.* One would scarcely have expected this. The general supposition would have been that the moisture contained in the soil would have exerted the same influence upon the more easily soluble portions of the manure as did the water applied to it in the cistern of the drill, and that therefore the crop would have been equally vigorous and healthy where the manure was sown dry as where sown in a liquid form. But the result proved otherwise.

In conclusion, I would strongly recommend all my agricultural friends to give the water-drill system a fair and early trial, testing its merits by every conceivable experiment, that its value may be fairly estimated; and I doubt not many will then be able to record as great success and as satisfactory results as I have done.

Aylesby House, Chatteris.

XX.—*On the Composition of Sorghum Saccharatum (Holcus Saccharatus) or North China Sugar-Cane.* By Dr. Augustus Voelcker.

The cultivation of the North China sugar-cane, sorghum saccharatum (holcus saccharatus), the sorgo sucré of the French, has of late attracted much attention. During the past season it has been grown in many places in England by way of experiment.

This new graminaceous plant appears to be cultivated largely in several parts of North America, where it has attracted much attention on account of the sugar which it contains, and likewise on account of its adaptation to the distillation of spirit and the preparation of fermented liquors. It is a beautiful-looking grass, resembling in appearance Indian corn. In favourable climates it comes to maturity in a single season, and reaches a height of from 12 to 16 feet. Sorghum sugar, when refined, is identical in composition and quality with cane-sugar. Sorghum saccharatum is recommended chiefly as a new material for the manufacture of sugar, and likewise as a nutritious and fattening food for horses and cattle.

The sorghum which was used for analysis was grown on the Royal Agricultural College Farm. The seed was drilled on the 13th of May, in rows 14 inches apart, and at a depth of about 3 inches. It came up well and evenly. The plants appeared to grow vigorously throughout the summer, and reached a height of about 5 feet by the beginning of October. A patch of about $\frac{1}{4}$-acre furnished a good deal of green food to cattle, which seemed not to relish it at first, but towards the end of September grew very fond of it. The soil on which the sorghum was grown was in good condition, of moderate depth, and, like most soils in our neighbourhood, contains a good deal of lime and clay, and scarcely any sand. The preceding crop was potatoes. As this crop had been heavily manured, no farmyard dung was put on the land this season, nor was any other manure employed, except some ashes from burnings of roadside parings and the clippings of hedgerows.

The sorghum was submitted to analysis at two different periods, namely, on the 23rd of August and on the 26th of September, 1859.

Composition of Sorghum, analysed August 23rd.

Water.—At this time the plants had no proper stems. The stalks consisted merely of leaves rolled up, which could be entirely untwisted.

As there was a good deal of adhering water on the leaves, it was necessary to unroll all the leaves, and to dry them with fine blotting paper, before making the water-determination.

Deprived in this way of all accidental water, 1000 grains of the finely cut plant left, on drying in the water-bath, 148 grains of dry matter. The plants consequently contained 85·20 per cent. of water.

In a second determination, 85·15 per cent. of water was found. The mean of the two water determinations is 85·17.

Ash.—18·61 grains of perfectly dry substance gave 1·41 grains of ash, or 100 grains contained 7·57 grains of ash. In the natural state the plants thus contained 1·12 per cent. of ash.

Protein Compounds.—Burned with soda-lime, the dried substance was found to contain 2·75 per cent. of nitrogen, which is equal to 17·18 per cent. of protein compounds. In a second nitrogen combustion, 2·78 per cent. of nitrogen was obtained, which is equal to 17·37 per cent. of protein compounds. The mean of these two nitrogen determinations is 2·76 per cent., equal to 17·27 per cent. of protein compounds. In the natural state sorghum contained, according to the first determination, ·407 per cent. of nitrogen, equal to 2·544 per cent. of protein compounds; and ·412 per cent. of nitrogen, equal to 2·575 per cent. of protein compounds, according to the second determination.

According to these determinations, the general composition of the sorghum on the 23rd of August may be represented as follows:—

	First Experiment.	Second Experiment.	Average.
Water	85·200	85·150	85·175
Nitrogenized organic matters (so called flesh-forming matters)	2·544	2·575	2·559
Substances free from nitrogen, and fitted for the support of animal heat and the formation of fat	11·136	11·155	11·146
Inorganic matters (ash)	1·120	1·120	1·120
	100·000	100·000	100·000

And that of sorghum, dried at 212° F.:—

	First Experiment.	Second Experiment.	Average.
Nitrogenized substances	17·18	17·37	17·27
Non-nitrogenized matters (heat and fat-producing matters)	75·25	75·06	75·16
Inorganic matters (ash)	7·57	7·57	7·57
	100·00	100·00	100·00

I have likewise made a complete proximate analysis of the sorghum; and, with a few modifications, followed the process which will be found described in detail in my Paper on the Composition of Parsnips and Belgian Carrots. (See Journal of the Royal Agricultural Society of England, vol. xiii., part ii.)

The following table contains the results of the detailed proximate analysis of the sorghum:—

Detailed Proximate Composition of Sorghum Saccharatum on the 23rd of August.

	In Natural State.	Dried a 212°.
Water	85·17	..
* Albumen	·36	2·42
* Other soluble protein compounds	·90	6·08
Mucilage, pectin, and digestible fibre	6·63	44·71
Soluble mineral matters	·81	5·46
†Insoluble protein compounds	1·25	8·43
Indigestible woody fibre (cellular)	4·57	30·81
Insoluble mineral matters	·31	2·09
	100·00	100·00
*Containing nitrogen	·21	1·71
†Containing nitrogen	·20	1·35
Total quantity of nitrogen	·41	2·76

It will be seen that the sorghum contained a good deal of nitrogenized matter at the time when the analysis was made, but no sugar whatever.

The taste of the plants on the 23rd of August was anything but sweet. I did not expect, therefore, to find much sugar, but I was unprepared to meet with a total absence of sugar. In order to verify this fact, I caused a direct sugar-determination to be made in a fresh and large quantity of the whole plant, but was unable to detect any appreciable quantity of sugar.

Horses and cattle to whom the plants were given, at first refused them altogether, and after some time partook only sparingly of this food. They evidently did not relish it.

There can be but little doubt that the sorghum was quite unripe by the end of August, and was unfit for feeding purposes.

It is worthy of special notice that the plants contained no sugar at that time. Last summer was unusually hot, but, notwithstanding, the plants were quite unfit for feeding by the end of August.

Fortunately, the last week in August and the month of September were warm; the plants therefore continued to grow vigorously, and formed perfect stems, which to the taste were very sweet when examined on the 26th of September.

Composition of Sorghum on the 26th of September.

The plants were cut about 4 inches above the ground. The analysis was made with the whole plant.

a. *General Composition.*

	In Natural State.	Dried at 212°.
Water	81·80	..
Soluble organic matter	8·16	44·83
Soluble mineral matter	·74	4·07
Insoluble organic matter	9·07	49·83
Insoluble mineral matter	·23	1·27
	100·00	100·00

b. *Detailed Proximate Composition of Sorghum Saccharatum, September 26th*, 1859.

	In Natural State.	Dried at 212°.
Water	81·80	..
*Albumen	·37	2·03
*Other soluble protein compounds	1·16	6·36
Sugar	5·85	32·15
Wax and fatty matter	2·55	14·01
Mucilage, pectin, and digestible fibre	2·59	14·26
Soluble mineral matters	·74	4·06
†Insoluble protein compounds	·66	3·62
Indigestible woody fibre (cellular)	4·05	22·25
Insoluble mineral matters	·23	1·26
	100·00	100·00
*Containing nitrogen	·245	1·34
†Containing nitrogen	·106	·58
Total quantity of nitrogen	·351	1·92

The sorghum contained, it will be noticed, nearly 6 per cent. of sugar on the 26th of September. Cattle supplied with this grass at that time greedily ate it, and, to all appearance, did well upon it.

The proportion of sugar in the whole plant is about the same as that in carrots.

On examining the stumps which were left in the ground, they were found much sweeter than the upper part of the stems. The difference in the taste was so marked, that I had made two direct sugar-determinations by the fermentation process.

The first determination was made in the stems cut about 2 inches from the ground. It gave 7·65 per cent. of sugar.

The second was made in the upper part of the stems, cut about 12 inches from the ground. It yielded 3·60 per cent. of sugar, or not quite half the quantity which was found in the lower part.

At the same time I determined the amount of crude fibre (the part insoluble in water) in both cases, and found in the lower

part of stems 6·50 per cent. of crude fibre, and in the upper part 13·01 per cent.

We have thus—

Proportion of Sugar and Crude Fibre.

	In Stems cut 2 inches above ground.	In Stems cut 12 inches above ground.
Percentage of sugar	7·65	3·60
" crude fibre.. ..	6·50	13·01

This distribution of sugar and fibre in the stems of sorghum is interesting in a physiological point of view. Whilst speaking of the distribution of sugar in sorghum, I may state that Professor Buckman observed last September that, whilst the principal or main stem was quite sweet, the stolons or side shoots were still bitter. It would thus appear that this grass does not ripen together; the central or oldest stem is perfect before the lateral shoots. Fearing the central stems might get so hard and woody as to become useless as a cattle-food if left in the ground until sufficient sugar is developed in the lateral shoots, Professor Buckman recommends that the central stems should be cut down first; the lateral shoots will then make rapid growth and gradually become sweet. By this simple expedient, the full benefits from the whole of the crop may be secured.

A comparison of the analysis made in August with that made in September will show several matters of interest. I notice some of the more striking ones.

1. In August the sorghum was much more watery than in September. In the former month it contained, in round numbers, 85 per cent. of water; in the latter only 81½ per cent.

2. Whilst there was a total absence of sugar in August, the whole plant contained nearly 6 per cent. in September in its natural state, or 32 per cent. when dry.

3. Instead of sugar, the sorghum contained in August chiefly mucilage and pectin, which constituents disappeared to a great extent in September, and gave rise to the formation of sugar.

4. The amount of woody fibre is less in the more matured grass than in the unripe plants analysed in August.

5. The unripe plants contain more mineral matter than the grass in a more advanced state of ripeness.

6. It is particularly worthy of notice to observe the larger amount of nitrogen in the immature grass. In the grass analysed in August there is ·41 of nitrogen, notwithstanding the larger amount of water; whilst in the plants analysed in September, and containing about 3½ per cent. less water, only ·35 of nitrogen was found. It will be seen that the proportion of insoluble protein compounds is considerably diminished in the September

produce. The differences in the relative proportion of nitrogen in the grass analysed at the two periods appear particularly striking, if the compositions of the dried substances are compared with each other. It will then be found that there is nearly 1 per cent. less nitrogen in the plants analysed in September than in the grass analysed in August.

We have here presented to us a fresh proof that the nutritive value of food of the same kind is not regulated by the amount of nitrogen which it contains, but rather by the proportion of sugar. Indeed, I think it may be safely asserted that all green food, and likewise turnips and other roots, are immature, and more or less unfit for feeding, when they are rich in nitrogen. Fully ripe and very nutritious roots and grass always contain less nitrogen than the same food in an immature state, or than food of indifferent feeding qualities.

A single year's trial of course does not entitle me to judge of the agricultural merits of the sorghum saccharatum; but I cannot help thinking that the climate in most parts of England is opposed to its growth in anything like full perfection. Last season we had a fine and warm summer; notwithstanding which, neither the field crop nor an experimental plot in the botanical garden came to full maturity. They scarcely reached 5 feet in height, which is very much lower than the height which this grass is reported to reach in America. I notice in a communication of Dr. Gössman of Philadelphia that in America the sorghum reaches a height of 12 to 16 feet, and that it furnishes 70 to 75 per cent. of juice, from which Dr. Gössman obtained 6 to 7 per cent. of good crystallized sugar, besides a quantity of molasses. It appears to me more than doubtful that the sorghum will grow to this height in many parts of England; nor do I think the cultivation of sorghum in England will be remunerative in furnishing the raw material for the manufacture of sugar or the distillation of spirits. However, repeated trials are needed before we can finally pronounce on the value of sorghum for the manufacture of sugar, or on its merits as a feeding stuff.

For the benefit of those who are inclined to give this new grass a trial next season, I append the following remarks on its culture by Professor Buckman, who says:—

"The seed was obtained from Messrs. Sutton, Reading, and sown in the beginning of May. The distance apart was 20 inches; depth (at which seed was sown), not more than 3 inches. It came up soon, and for the first month did not at all promise the fine aspect it afterwards showed; but as soon as the warm nights came it made rapid growth, and we were thus led to infer that too early sowing is by no means a saving of time, though we are not quite sure whether getting strong plants early, by germinating in a hothouse or under glass with artificial heat, and gradually exposing them to harden before transplanting, would not be advisable, especially where the growth of

holcus is attempted in cold, exposed, or late-growing situations; and, in this case, of course the operation of transplantation should be done in wet weather, the saving of seed, and the ensuring of a well-regulated equidistant plant, being taken as no bad equivalent for the extra labour and expense. In this case the crop was hoed, but this is a delicate operation with the sorghum, as it sends out adventitious roots from the joint immediately above the ground, which dip into the soil, and, if not interfered with, aid immensely in forwarding the growth and developmemt of the plant. Hoeing, then, before this process commences encourages it, but by no means can it be properly done when this is in progress. When, however, the new roots are fully established, a careful stirring of the ground between the rows (not between the individual plants) appears very much to facilitate a larger and, what is more important, a quicker growth."

Royal Agricultural College, Cirencester,
Dec. 1859.

The foregoing article by Dr. Voelcker contains some curious and instructive facts. That the specimens of sorghum examined by him should have contained no sugar at the end of August, and up to that time should have been unpalatable to horses and cattle, are circumstances which not only have an important bearing on the probable value of the sorghum as a fodder plant in this climate, but they show what great changes may take place in a growing plant without any external difference being perceptible. This clue if properly followed up is very likely to lead to the right explanation of many apparent contradictions in the experience of practical men as to the value of any particular root or plant as food for stock, and it appears to me highly desirable that an extensive series of observations should be made on the changes which take place from time to time in the constituents of our root and fodder crops during their whole period of growth, but especially at the time of their approach towards maturity. The inquiry whether any material alteration takes place either for better or worse in the juices or tissues of a swede or a mangold at the fall of the leaf, or shortly before or after that time, or whether our natural or artificial grasses vary much in their composition and consequent value during the successive months of spring and summer, involves questions of first-rate interest to the farmer, and might materially assist him in fixing the time for mowing his meadows or storing his roots. I may perhaps be considered over sanguine for seeking to connect with such an investigation questions of a still more extensive character, but it certainly appears to me probable that a sufficiently extended scientific inquiry of the kind above named would throw considerable light on the whole question of manures, and their effect on the composition as well as the growth of plants. But whether these ultimate results be realised or not, the direct

and immediate objects to be obtained by such an examination of our cultivated crops are so full of interest that I venture to express the hope that Dr. Voelcker will closely follow up what he has so hopefully inaugurated in the short paper before us.

One point in Dr. Voelcker's trial of the sorghum requires special attention on the part of future experimenters, viz. the period at which the plant begins to be palatable to live stock. A small plot of it sown here (West Riding of Yorkshire) last April in a well-sheltered garden grew vigorously and produced a large amount of both leaves and stems, the latter fully six feet high; both were greedily eaten by horses and cattle as early as the month of July, and from that time until the end of October, when it was cut down by frost. No special manure was applied to this plot, but the land was in the high condition which is usual in the case of garden ground.

From the late period at which its growth commences, it is not probable that the sorghum will be able to compete with our clovers, &c., as a general crop for soiling, but two points are already ascertained beyond doubt, viz., that a small piece of land devoted to this plant will raise a large amount of produce, and that at a certain period (to be hereafter ascertained) this produce acquires considerable feeding value.

If it should be generally found to be as palatable to stock in July, as it was here, it will be very useful for soiling during the months of August and September; if, however, like Dr. Voelcker's, it should in most cases be unfit for cattle food until late in September, it would still be worth while to try whether it might not be made into valuable hay, either by cutting it in autumn when the saccharine matter was fully developed, or by cutting earlier and stacking it sufficiently green to induce considerable fermentation in the stack. The sorghum is naturally a plant of rapid growth, and it is possible that heavy doses of guano or other highly concentrated manure might force on its growth sufficiently to obtain not only a greater weight of produce but earlier maturity. At all events those stockmasters who, like myself, often experience a lack of material for soiling for a few weeks after harvest, would do well to try experiments on a limited scale with the sorghum, which is evidently a plant of great capabilities.

H. S. THOMPSON.

XXI.—*Experiments with different Top-Dressings upon Wheat.* By Dr. Augustus Voelcker.

There is no lack of experiments made with guano, nitrate of soda, soot, shoddy, gas-water, and other nitrogenized substances, which are occasionally used as top-dressings upon wheat. Experience has shown that all these manures may be used, with more or less advantage, for the wheat-crop; and that, generally speaking, they are the more effective the more nitrogen they contain. Thus Peruvian guano or nitrate of soda, which are both very rich in nitrogen, are justly considered more powerful wheat-manures than soot or shoddy—two materials much poorer in this element. Whilst I consider the relative proportions of nitrogen in different fertilizers, intended to be used for wheat or other cereal crops, to be an important element in estimating the comparative commercial and agricultural value of artificial manures, such as Peruvian guano, nitrate of soda, or sulphate of ammonia, I am of opinion that the form or state of combination in which the nitrogen is contained in the manure materially affects its efficacy. Any one who has tried side by side nitrate of soda, Peruvian guano, and shoddy, must have felt surprised at the different degree of rapidity with which the effects of these three fertilizers are rendered perceptible in the field. I have noticed more than once that, under favourable circumstances, the effects of nitrate of soda became visible in the course of three or four days in the darker green colour and more luxuriant appearance of the young wheat, whilst it took eight or ten days in the case of guano to produce a similar effect. On wheat dressed with shoddy no apparent effect was produced even after the lapse of four or six weeks. So slow is the action of the latter that a superficial observer might well doubt the efficacy of shoddy as a wheat-manure, for it often produces no visible improvement in the wheat-crop, and it is only after threshing out the corn that it can be ascertained that shoddy has had some effect upon the yield of corn. These examples appear to indicate that nitrogen in the shape of nitric acid has a different practical value from that which it possesses in the shape of ammonia, and that it has again another value in the form of nitrogenized organic matter. It must be confessed that our knowledge of the comparative efficacy of nitrogen, in its various states of combination, is extremely limited, inasmuch as we scarcely possess any sufficiently accurate and trustworthy comparative field experiments which are calculated to throw light on this subject. As yet the sure foundation on which an explicit opinion as to the relative merits of nitrogen—in the shape of nitric acid, ammonia, or organic matter—can be given, is altogether wanting. It is true the

experience of practical men affords certain useful indications to the scientific observer, but nothing more. In the absence of clear, unmistakeable, and sufficiently extensive practical evidence, no definite answer can be given to the question so frequently addressed to the agricultural chemist, Shall I apply nitrate of soda or guano upon my wheat?

We do not know, even in a general way, the comparative efficacy of nitrates and of ammoniacal manures: how is it possible, I would ask, to answer such a question in a particular instance? The importance of this question will be admitted by every one, especially at a time when the price of corn is low, and that of Peruvian guano high. Extensive deposits of nitrates of potash and soda are more likely to be discovered when diligent search is made after them than new and extensive deposits of guano equal to, or approaching in efficacy, Peruvian. Apart from the theoretical aspect, the question as to the relative merits of nitrogen in the shape of nitric acid or ammonia is of great practical interest. Fully impressed with the importance of this subject, I have undertaken, at the request of the Council of the Royal Agricultural Society, a series of field experiments with top-dressings upon wheat, and have now the pleasure of laying before the members of the Society the results of a series of experiments made last season (1859). Similar experiments I hope to continue from year to year; for the longer I am engaged in carrying out experimental trials in the field, the more I am convinced that the experience derived from one, two, or three years' experimenting in the field is alike inadequate to further the progress of scientific agriculture, and to supply the farmer with information from which he can derive practical advantage.

The time has arrived when an extension of field experiments is imperatively demanded. Practical experiments should be instituted in all parts of the country, and tried on every description of soil, and under the most varied conditions. They should be conceived in a philosophical spirit, and carried out with that accuracy and love of truth which ought, and generally does, characterize the labours of the student of natural science. Mere random trials, made without plan or definite object in view, are only calculated to lead astray, and thus do more harm than good. Unfortunately, success in a field experiment cannot be always secured: the disturbing influences which spoil the result are numerous and frequently uncontrollable; and, as the labour, anxiety, and expense which attend field experiments are very great, it can hardly be expected that many agriculturists will engage in this work. After having gone to the trouble of preparing and measuring out the land, selecting the seed, procuring and weighing out the various fertilizers intended for trial, after having them analysed and taken notes from day to day of the

progress of the experimental plots, it is a sore trial for the experimentalist to have to report, "Results vitiated by the ravages of the black caterpillar." Indeed any one who is not prepared to meet with more disappointment than success, will be wise to desist from trying his hand at field experiments. I am led to make this remark because only the season before last my experiments upon swedes were entirely spoiled by the black grub. Again last season I instituted an extensive series of experiments with top-dressings upon barley, and, after having incurred considerable expense and taken much trouble, all that I can report is, "Results vitiated by the ravages of the wire-worm."

My experiments upon the wheat-crop, I am happy to say, were unusually successful. No hail, drought, mildew, or rust, interfered with the success of the trials. I was fortunate enough to find a good and most equal plant on a perfectly level and uniform field of the Royal Agricultural College farm. The day on which the top-dressings were applied was calm and cloudy; a moderate rain that fell on the next day washed the various manures into the soil, and secured at once their uniform distribution. The season, on the whole, was favourable to wheat, the weather at harvest time was unusually splendid, and on none of the experimental plots was the crop laid in the slightest degree.

The field on which the experiments were tried is perfectly level, and throughout of uniform depth. Its extent is about 20 acres; and last season the whole was in wheat after seeds; 2 acres covered with a very equal plant were measured out for the experiments and carefully divided into 8 parts of equal length and breadth. Each experimental plot thus occupied the space of $\frac{1}{4}$ acre. The 2 acres under experiment were surrounded by a considerable breadth of the general wheat-crop, except on one side. Although the headland, and a portion of the rest of the land, separated on that side the experimental plots from the adjoining hedge, it was considered prudent to reject the $\frac{1}{4}$ acre next to the hedge. Seven plots of $\frac{1}{4}$ acre each in extent thus were left. These plots were manured as follows:—

To Plot I. was applied 70 lbs. of Peruvian guano; or at the rate of $2\frac{1}{2}$ cwt. per acre.

„ II. „ 49 lbs. of nitrate of soda; or at the rate of $1\frac{3}{4}$ cwt. per acre.

„ III. „ 45 lbs. of nitrate of soda and 42 lbs. of common salt; or at the rate of $1\frac{1}{2}$ cwt. of salt and 180 lbs. of nitrate of soda per acre.

„ IV. „ 1 cwt. of Proctor's wheat manure; or at the rate of 4 cwt. per acre.

„ V. „ $1\frac{1}{2}$ cwt. of the same wheat manure; or at the rate of 6 cwt. per acre.

Plot VI. was left unmanured.

To Plot VII. was applied about 1 ton of chalk-marl; or at the rate of about 4 tons per acre.

These quantities of the different fertilizers were obtained in each case at an expense of 1*l.* 12*s.* 6*d.* per acre, except the larger dose of wheat-manure on Plot V., the cost of which was 2*l.* 8*s.* per acre. In this estimation the actual prices paid were taken. Peruvian guano, at the time of application, was 13*l.* per ton; nitrate of soda, 18*l.* 10*s.* per ton; common salt, 1*l.* 10*s.* per ton; wheat-manure, 8*l.* per ton.

The price of the chalk-marl could not be accurately ascertained, and probably 8*s.* per ton will be rather under than above the price at which it was procured. The manures were all finely sifted (except the chalk-marl), mixed with about 10 times their weight of fine soil, and sown broadcast on the afternoon of the 22nd of March, 1859.

The land was clean, in good condition, and moist. A portion of the soil from the experimental field was submitted to a mechanical and to a chemical analysis. It yielded the following results:—

Composition of Experimental Wheat-Field; Field No. 2 of the Royal Agricultural College Farm, Cirencester.

a. *Mechanical Analysis.*

Moisture	4·18
Organic matter and water of combination	9·75
Lime	18·63
Clay	61·76
Sand	5·68
	100·00

It will be seen that there is but little sand or silica, that can be separated by washing, in this soil. Notwithstanding, the straw of the wheat was very stiff.

b. *Chemical Analysis.*

Moisture	4·18
*Organic matter and water of combination	9·75
Oxides of iron and alumina	16·25
Phosphoric acid	·12
Sulphate of lime	·31
(Containing sulphuric acid)	(·18)
Carbonate of lime	18·63
Magnesia	·18
Potash	·41
Soda	·11
Insoluble silicates and sand (chiefly clay)	50·45
	100·39
*Containing nitrogen	·37
Equal to ammonia	·45

In the preceding analysis the phosphoric acid was determined by the molybdate of ammonia process, which furnishes exceed-

ingly accurate results. The proportion of phosphoric acid found (·12) is but small; nor does this soil contain much sulphuric acid or available alkalies. On the other hand, it is rich in lime and clay, and would, no doubt, be much more productive if the field were deeper. Being rather shallow, the agricultural capabilities of the experimental field are naturally below the average.

In shallow, stiff, and retentive soils organic matter accumulates rapidly. Most of the nitrogen indicated in the above analysis is present in the shape of organic matters: *i.e.*, the roots, leaves, and other remains of the preceding crop. A small portion only of nitrogen occurs in this soil in the state of ready-formed ammonia.

Before stating the yield of each experimental plot, I shall notice briefly the appearance of the crop at different times, and give the analysis of the manures employed in the experiments.

Plot I.—Top-dressed, March 22nd, with Peruvian guano, at the rate of 2½ cwts. per acre, cost, 1*l.* 12*s.* 6*d.* per acre.

On the eighth day after the application of the guano the effects of this fertilizer became slightly visible, on the tenth day they were a little more marked, and, after a fortnight, plainly observable even to a superficial observer. Compared with the unmanured wheat, the colour of the wheat on Plot I., though not so dark-green as on the portion dressed with nitrate of soda, was deeper, and the plants looked altogether more luxuriant than on the unmanured plot. The darker green colour was perceptible for more than six weeks, and then gradually disappeared. At the same time the wheat-plants grew more vigorously, and at harvest time were a good deal higher than the wheat in the surrounding field. On analysis the Peruvian guano gave the following results:—

Moisture	17·12
*Organic matter and ammoniacal salts	51·31
Phosphates of lime and magnesia (bone-earth)	22·55
Alkaline salts	7·94
Insoluble siliceous matter (sand)	1·08
	100·00
*Containing nitrogen	14·64
Equal to ammonia	17·77

These numbers express the composition of a genuine good Peruvian guano.

Plot II.—Top-dressed, March 22nd, with nitrate of soda, at the rate of 1¾ cwt. per acre, cost 1*l.* 12*s.* 6*d.* per acre.

Already, the fourth day after application, the effects of nitrate of soda became slightly visible, and in the course of a week the

dark green colour of the wheat on that plot was unmistakable. The wheat on Plot II. looked remarkably well throughout the season, and at harvest time was as high as the wheat dressed with guano. The nitrate of soda employed in this experiment was very pure, as will be seen by the subjoined analysis:—

Composition of Nitrate of Soda.

Moisture	1·87
Pure nitrate of soda	95·68
Chloride of sodium	·79
Sulphate of soda	1·17
Sand	·49
	100·00

PLOT III.—Top-dressed, March 22nd, with nitrate of soda and salt, at the rate of 180 lbs. of nitrate of soda and 1½ cwt. of salt per acre, cost 1*l.* 12*s.* 6*d.* per acre.

The remarks made with respect to Plot II. apply equally well to this plot. There was no visible difference in the appearance and general character of the wheat on Plots II. and III., and at harvest time it was impossible to say which of the two would yield the heavier crop.

Many persons who passed by the wheat-field, which could be overlooked from the turnpike-road, were astonished at the dark-green coloured wheat on the two plots upon which nitrate of soda was put. In comparison with the surrounding wheat, which had received no top-dressing, the two ¼-acre plots looked as if a painter had put an extra layer of green colour on the wheat. The common salt used on Plot III. was ordinary agricultural salt.

PLOT IV.—Top-dressed, March 22nd, with wheat-manure (Proctor's), at the rate of 4 cwts. per acre, cost 1*l.* 12*s.* 6*d.* per acre.

The effects produced by this top-dressing were not so soon visible as those produced by nitrate of soda. However, in less than a fortnight the wheat was decidedly improved, and, as far as appearance went, kept pace with the wheat dressed with guano. At harvest time it was impossible to say which of the Plots, No. I., II., III., or IV., was the best. An inspection of the following analysis will show that the wheat-manure used on this and following plot was an excellent fertilizer. It will be noticed that it contained a large quantity of nitrogen, partly as sulphate of ammonia, partly in the shape of soluble and insoluble nitrogenized organic matter. In addition to these important constituents, it contained both soluble and insoluble phosphates, as well as common salt, gypsum, and a few other matters of less value.

Composition of Wheat Manure.

Moisture	13·60
*Sulphate of ammonia	10·97
† { Soluble nitrogenized organic matter	8·08
† { Insoluble nitrogenized organic matter	14·72
Bi-phosphate of lime	3·54
Equal to bone-earth rendered soluble by acid	(5·52)
Insoluble phosphate of lime (bone-earth)	9·45
Sulphate of magnesia	·61
Hydrated sulphate of lime	19·73
Chloride of sodium (common salt)	16·84
Insoluble siliceous matter (sand)	2·46
	100·00
*Containing nitrogen	2·32
Equal to ammonia	2·82
†Containing nitrogen	3·53
Equal to ammonia	4·28
Total quantity of nitrogen	5·85
Equal to ammonia	7·10

Plot V.—Top-dressed, March 22nd, with Proctor's wheat-manure, at the rate of 6 cwts. per acre, cost 2*l.* 8*s.* per acre.

During the first three or four weeks there was no difference perceptible in Plots IV. and V., but in the beginning of June it became plain to a careful observer that the wheat on this plot was evidently all the better for the extra dose of manure.

The wheat continued to improve, and took the lead of the experimental plots. At harvest time the wheat on this plot was perceptibly higher in straw than on any of the other plots, and the ears of corn likewise appeared rather longer and better filled than on any of the other portions of the experimental field. The reapers, without exception, pronounced the crop on Plot V. the heaviest of all; and the correctness of their opinion, it will be shown, was fully borne out by the direct weighings of the yield. The contrast in the appearance of this plot and the rest of the general wheat-crop was most striking. Although the wheat on No. V. was high, it stood perfectly erect at harvest, and produced strong healthy straw.

Plot VI.—Left unmanured.

The wheat on this plot was fully three inches lower than on the preceding plot. Although it was not so dark green as the crop on Plots I., II., III., IV., V., it was, nevertheless, healthy-looking, but rather thin.

Plot VII.—Top-dressed with chalk-marl, at the rate of about 4 tons per acre.

There was not the slightest difference perceptible in this and

the preceding plot, and it was plain to any one that the marl had had no effect whatever. On analysis this chalk-marl was found to have the following composition:—

Composition of Chalk Marl.

Moisture	2·49
Carbonate of lime	69·23
Oxides of iron and alumina	·36
Phosphate of lime (bone-earth)	·63
Sulphate of lime	trace
Magnesia and alkalies	·45
Soluble silica	8·29
Insoluble siliceous matter (fine sand)	18·55
	100·00

Towards the end of July the crop was nearly ripe; at that time I could not notice any marked difference in the state of ripeness of the crops on the 7 experimental $\frac{1}{4}$-acres.

The wheat was reaped in the first week of August, and threshed out on the 24th of August, 1859, and the whole of the produce of corn and straw carefully weighed: it was omitted, however, to weigh the chaff and cavings.

The following Table exhibits the yield of corn of each experimental plot, and the produce calculated per acre:—

TABLE *showing the Produce, in lbs. and bushels, of Corn of Experimental Plots of $\frac{1}{4}$-acre, and Weight and Bushels per acre. (Average weight per bushel, 60 lbs.)*

Plot		Produce in corn per plot.		Produce in corn per acre.	
		lbs.	bushels.	lbs.	bushels.
I.	$2\frac{1}{2}$ cwt. guano per acre	$601\frac{1}{2}$	10	2406	$40\frac{1}{10}$
II.	$1\frac{3}{4}$ cwt. of nitrate of soda per acre ..	570	$9\frac{1}{2}$	2280	38
III.	180 lbs. of nitrate of soda and $1\frac{1}{2}$ cwt. of salt per acre	609	10	2436	$40\frac{6}{10}$
IV.	4 cwt. of Proctor's wheat-manure per acre	595	10	2370	$39\frac{1}{2}$
V.	6 cwt. of ditto per acre	663	11	2652	$44\frac{1}{5}$
VI.	Unmanured	405	$6\frac{3}{4}$	1620	27
VII.	Chalk-marl, 4 tons per acre	$404\frac{1}{2}$	$6\frac{3}{4}$	1618	27

By direct weighings it was found that the weight per bushel was in—

No. I.	$60\frac{1}{2}$ lbs.	No. V.	60 lbs.
„ II.	60 „	„ VI.	60 „
„ III.	$60\frac{3}{4}$ „	„ VII.	$60\frac{1}{2}$ „
„ IV.	$60\frac{1}{2}$ „		

Practically speaking, there was thus no difference in the weight of corn per bushel. Not having had much experience in filling bushels of corn, I found that I could not always fill the bushel-

measure so uniformly as not to get a difference of from ¾ to 1 lb. in the weight of different bushels of the same corn.

The following table exhibits the produce in straw :—

TABLE *showing the Produce in Straw of each ¼-acre Plot, and Produce per acre.*

Plot		Per plot. cwt.	qrs.	lbs.	Per acre. ton	cwt.	qrs.	lbs.
I.	2½ cwt. of guano	5	3	0	1	3	0	0
II.	1¾ cwt. of nitrate of soda ..	6	0	2	1	4	0	8
III.	180 lbs. of nitrate of soda and 1½ cwt. of salt	6	0	12	1	4	1	20
IV.	4 cwt. of wheat-manure	5	3	23	1	3	3	8
V.	6 cwt. of wheat-manure	6	3	2	1	7	0	8
VI.	Unmanured	4	1	20	0	17	2	24
VII.	Chalk-marl	4	0	20	0	16	2	24

For the sake of better comparison, the increase per acre in corn and straw over unmanured portions of the experimental field, is stated in the next Table.

TABLE *showing the Increased Produce per acre in Corn and Straw over Unmanured Plot, in lbs. and bushels.*

Plot		Increase in corn. lbs.	bushels.	Increase in straw. cwt.	qrs.	lbs.
I.	Peruvian guano	786	13$\frac{1}{10}$	5	1	4
II.	Nitrate of soda	660	11	6	1	12
III.	Nitrate of soda and salt	816	13$\frac{6}{10}$	6	2	24
IV.	4 cwt. of Proctor's wheat-manure	750	12½	6	0	12
V.	6 cwt. of ditto	1032	17⅕	9	1	12
		produce.		produce.		
VI.	Unmanured	1620	27	17	2	24
		increase.		decrease.		
VII.	Chalk marl	none		1	0	0

An examination of the preceding results suggests the following remarks :—

1. The plot manured with chalk-marl furnished as nearly as possible the same amount of corn as the unmanured plot, and rather less straw. The produce in the one amounted to 1620 lbs. of corn, and in the other to 1618 lbs.; or each gave 27 bushels of wheat.

In some parts of England chalk-marl is applied with considerable benefit to the wheat-crop, but as the soil of the experimental field contained 18 per cent. of carbonate of lime, it could not be expected that a marl, which owes its fertilizing properties almost entirely to the carbonate of lime and to a little phosphate of lime which it contains, should produce any marked effect upon the

wheat-crop. Indeed, I did not expect any increase from the application of this marl, and used it in this experiment chiefly to ascertain the extent of variation in the produce of two separate $\frac{1}{4}$-acre plots. The result plainly shows that the experimental field was very uniform in its character and productiveness. We may also learn from this result that the efficacy of a manure is greatly affected by the chemical composition of the soil to which it is applied. However beneficial chalk-marl may be in other localities, it cannot possibly do any good on land which contains already an abundance of the same elements which are supplied in the marl.

2. The application of only $1\frac{3}{4}$ cwt. of nitrate of soda raised the produce in corn to 38 bushels, and that of straw to 1 ton 4 cwt. 8 lbs. We have thus here an increase of 11 bushels of corn, and $6\frac{1}{4}$ cwt. of straw, at an expense of 1*l.* 12*s.* 6*d.*

3. By mixing nitrate of soda with common salt, the produce in corn was raised to 40 bushels, and that of straw to 1 ton 4 cwt. 1 qr. 20 lbs. It appears thus that the admixture of salt to nitrate of soda was beneficial in this experiment. The quantity of salt used amounted to only $1\frac{1}{2}$ cwt.: notwithstanding, it had a decidedly beneficial effect upon the produce. As salt is cheap, it may be worth while to try in future experiments whether a larger dose of salt mixed with nitrate of soda will be of advantage.

4. Peruvian guano produced very nearly the same quantity of corn as the mixture of nitrate of soda and salt, but somewhat less straw.

5. The smaller dose of wheat-manure gave almost $\frac{1}{2}$ a bushel less increase in corn, and rather more straw, than guano. The difference in the yield of these two plots, however, is trifling.

6. The larger dose of Proctor's wheat-manure (6 cwt. per acre), it will be seen, gave an increase of $17\frac{1}{5}$ bushels of corn, and 9 cwt. 1 qr. 12 lbs. of straw, over the yield of the unmanured plot. 4 cwt. of the same wheat-manure gave an increase of $12\frac{1}{2}$ bushels of corn, 6 cwt. 12 lbs. of straw. One-half more of wheat-manure, or 6 cwt., very nearly gave one-half more increase in corn and straw. The chief points of interest which attach to these experiments are:—

1. That nitrate of soda applied by itself materially increased the yield of both straw and corn.

2. That the admixture of salt to nitrate of soda was found to be beneficial.

3. That guano produced as good a result as nitrate of soda.

4. That the increase in corn and straw corresponded with the quantity of the wheat-manure which was used.

5. That ammonia and nitrogenized organic matters—which

proved inefficacious or even injurious in relation to turnips, grown on a similar soil to that on which the wheat was raised—had a most marked and decidedly beneficial effect upon the wheat-crop.

It may not be amiss to contemplate these experiments in an economical point of view, and to ascertain to what extent the different top-dressings have repaid the outlay of money—which, it will be remembered, was 1*l.* 12*s.* 6*d.* per acre in all cases, except in the case of the larger dose of wheat-manure, the application of which entailed an expenditure of 2*l.* 8*s.* per acre. Leaving unnoticed the extra produce of straw, which in some cases was considerable, I shall only take into account the produce in corn. The present average price of wheat of ordinary quality is about 42*s.* per quarter. Taking 42*s.* as the price of wheat per quarter, we obtain the following money-value of the increase in produce, as the clear profit realized by the top-dressings after deducting the expense of the manures:—

TABLE *showing the Money Value of Increase in Corn per acre over Unmanured Plot, and Clear Profit after deducting the price paid for Manures.*

Plot		Money increase in corn. £.	s.	d.	Cost of Manure. £.	s.	d.	Clear Profit. £.	s.	d.
I.	Guano	3	8	9	1	12	6	1	16	3
II.	Nitrate of soda	2	17	9	1	12	6	1	5	3
III.	Nitrate of soda and salt	3	11	5	1	12	6	1	18	11
IV.	4 cwt. of wheat-manure	3	5	7	1	12	6	1	13	1
V.	6 cwt. of wheat-manure	4	10	4	2	8	0	2	2	4
VI.	Unmanured	..	..		..	..		..	..	
VII.	Chalk-marl	none			1	12	6	loss. 1	12	6

It will be seen that, with the exception of the chalk-marl, all the top-dressings paid very well, and that the more liberal outlay for manure produced by far the best return in money.

I purpose to note down the relative produce of next season's crop on each of the ¼-acre experimental plots, and hope thus to ascertain whether the efficacy of the various top-dressings was spent in one season or not. In estimating the profits arising from the use of these top-dressings, the condition in which the land is left after the removal of the crop ought, by rights, to be taken into account. It appears to me that the productiveness of the different plots will be found to vary considerably.

In nitrate of soda we have only two constituents, namely, soda and nitric acid. Soda has scarcely any fertilizing value, and in combination with nitric acid it is, moreover, readily removed by

the rain into the subsoil or drainage water; for soils do not possess the power of retaining nitrates. Supposing any nitrate of soda to have been left in the soil, it is not likely to produce any effect on the succeeding crop. All the more important mineral constituents which are required for the growth of wheat must be furnished by the soil top-dressed with nitrate of soda. The amount of available mineral fertilizing matters in the soil, therefore, will be less after the removal of the wheat-crop, and the soil will be found, I think, in a poorer condition.

The portions of land top-dressed with guano and wheat-manure, on the other hand, were supplied not only with ammoniacal salts and nitrogenized organic matters, but also with valuable mineral matters—such as phosphoric acid, sulphuric acid, and alkalies. On calculating the proportion of phosphoric acid which is removed in the produce of Plot I., I find that the guano supplies more phosphoric acid than is removed in the produce of corn and straw. After harvest, therefore, the land will actually be richer in this important fertilizing matter than it was before the application of guano. Again, I question very much whether the total amount of nitrogen in guano and in the wheat-manure will be used up in the growth of one wheat-crop. It appears to me more likely that some will remain in the soil, ready to benefit the succeeding crop. However, this point can only be decided by direct experiments. Unlike nitrates, ammoniacal matters are retained in all soils containing a fair proportion of clay, which circumstance is of course in favour of guano and ammoniacal manures in general as top-dressings for wheat.

Since, then, guano and artificial manures, resembling in composition the wheat-manure used in my experiments, supply the wheat-crop with constituents which must be furnished entirely by the soil when nitrate of soda alone is employed as a top-dressing; and since an excess of ammoniacal matter will be retained in the soil, whereas an excess of nitrate is subject to loss; I am inclined to think that the land dressed with guano and Proctor's wheat-manure will be left in a better condition than the plots manured with nitrate of soda. On the whole, I am of opinion that in the recorded experiments the wheat-manure and guano have proved to be preferable as top-dressings to nitrate of soda. However, nitrate of soda is an excellent material for producing a rapid improvement in sickly-looking wheat. We have used nitrate of soda last season with great advantage on our farm. A slight sprinkling with a mixture of nitrate of soda and salt causes a marvellous improvement in poor, thin, yellow-looking wheat. On the thin brashy soils in our neighbourhood the young wheat is apt to turn yellow and sickly in dry springs, especially on the brows of hilly fields: nothing can be better in such a case than

a dressing with nitrate of soda and salt. By this means Mr. Coleman, who manages the Royal Agricultural College farm, has been able to grow good crops of wheat on thin brashy and exposed fields, which usually without such a dressing yielded but a scanty produce.

Nitrate of soda and guano often contain hard lumps, which ought to be carefully broken down before application: this is generally neglected, to the great disadvantage of the farmer. It is true there is some difficulty in reducing guano to a fine powder, and there is trouble connected with passing through a fine sieve nitrate of soda or guano; but no trouble or additional expense for labour should deter any one from reducing artificial manures, intended to be used as top-dressings, into a fine powdery condition: for the difference in the efficacy of manures in such a condition, and the same manures applied in a rough state, is much greater than most people believe who have not tried the experiment.

Whilst speaking of the application of top-dressings, I cannot refrain from observing that all artificial manures—such as nitrate of soda, guano, or a mixture of nitrate of soda and salt—should not only be first passed through a fine sieve, but they should also be mixed with three to five times their own weight of fine red ashes, dry soil, or sand, before sowing them broadcast by hand, or, what is much more convenient and better, by the broadcast manure distributor. Chambers' or Reeves' dry manure distributor cannot be too highly recommended for sowing, in a most uniform and expeditious manner, top-dressings of every description.

In conclusion, I beg publicly to thank Mr. Coleman for the obliging manner in which he has assisted me in carrying out the preceding experiments.

Royal Agricultural College, December, 1859.

XXII.—*Report of Experiments with different Manures on Permanent Meadow Land.* By J. B. Lawes, F.R.S., F.C.S., and Dr. J. H. Gilbert, F.C.S.

(Continued from p. 272.)

Part IV.—Chemical Composition of the Hay.

Thus far it has been shown, that the produce of hay on permanent meadow land was more than doubled by means of manure alone. It has also been shown, that the description of the produce grown on the manured land was very different from that on the unmanured; and again, that it was widely different according to

the kind of manure employed. The proportions respectively of the Graminaceous, the Leguminous, and the other herbage, varied very considerably ; so also did the kind and amount of the several plants comprised within each of these main divisions; and so also did the proportions of leaf, stem, and seed, and the condition of maturity.

Now the Leguminous herbage generally contains about twice as high a percentage of nitrogen as the Graminaceous. It also varies in composition in other respects. Leaves, stems, and seeds, differ much in composition from one another. And again, the degree of maturity of vegetable produce very much affects its percentage amount of certain important constituents. It will be obvious, therefore, that the composition of the complex produce —*hay*—must vary very considerably when grown by different manures.

The object of this Fourth and last Part of our Paper is to show the variation according to season, and manuring, in the composition of the hay grown on the different experimental plots, the particulars of the manuring and produce of which have already been so fully considered in other points of view.

In each of the three seasons over which the experiments have extended, the percentage amounts of *total dry substance*, of *mineral matter*, and of *nitrogen*, have been determined in the produce from each of the separate plots. The *woody fibre* has been determined in the produce of each of the three years of those plots, which, in 1858, were selected for the botanical separations described in Part III. The *fatty matter* has been estimated in the produce of the same plots, but in that of the third season (1858) only. Lastly, complete analyses of the ashes of the produce of five out of the seven plots selected for the botanical separations, and also of the mixed ash of the produce from all the plots, for each of the three years separately, have been made. The various analytical results will now be considered under separate heads.

Dry Matter.

From each of the experimental plots, at the time the hay was carted, a sackful was taken, the samples being gathered from many parts of it. The whole of each of the specimens so taken was then cut into chaff and well mixed. From the mixed sample in this condition two quantities of 25 ounces each were weighed, and in both of these the *dry matter* and the *mineral matter* were determined. Other samples were at the same time taken for the determinations of nitrogen, woody fibre, &c.

The *dry matter*, which alone is at present under consideration, was determined by submitting the duplicate 25-ounce samples,

for a sufficient length of time, to a temperature of 212° F. in a large water-bath. The *means* only, of the two determinations in each case, are given in Table XI. These will be quite sufficient for the elucidation of the points to which the results are applicable. But the individual determinations are given for reference in Table I. in the Appendix.

In the lowest division of Table XI. are given the *mean* percentages of Dry matter of all the specimens for each of the three seasons. The average percentage for all the specimens of 1856 was 79·3; that for 1857 was 86·8; and that for 1858 was 84·1. The mean percentage over the three years together was 83·4. There was, therefore, a variation in the average proportion of Dry matter in the hay of more than 7 per cent., according to *season.* The produce of 1857 gave a very high, and that of 1856 a very low proportion, of Dry substance.

The season of 1856 was, in every respect, ill adapted for high and dry condition of the hay. Accordingly, analysis indicates a very low percentage of Dry matter in the produce of that season. The seasons of both 1857 and 1858 were very much better in this respect. Of the two, the produce of 1857 contained considerably the higher proportion of Dry matter. But a comparative examination of the climatic statistics of these two seasons leads to the conclusion, that the higher percentage of Dry matter in the produce of 1857 is not so much due to the conditions during the last two or three weeks before cutting, as to the influence of climatic circumstances somewhat earlier, which developed more the seeding tendency in 1857 than in 1858.

Among the percentages of Dry matter relating to the produce of the individual plots, there is not a single instance that does not show the same general relationship between the characters of the three seasons on this point, as is indicated by the mean results only of each season.

Nor was there much difference between the average proportion of Dry matter in the specimens of the produce of each season taken at the time of carting, and that found in the bulk of the hay from the same (and adjoining land) after it had been some time in the rick. As a check on this point, samples were cut from the top to the bottom of the ricks which contained the mixed produce, both experimental and otherwise, of the seasons of 1857 and 1858 respectively, and the Dry matter was determined in them. The results are given at the foot of Table XI.; and the comparison afforded is as follows:—The average percentage of Dry matter in the experimental specimens of 1857 was 86·8; and that in the hay taken from the rick of that year (sampled Dec. 1858) was 87·2. Again, the average percentage of Dry matter in the experimental specimens of 1858 was 84·1; and that in the hay

TABLE XI.—PERCENTAGES of DRY SUBSTANCE in the HAY (Means of duplicate Determinations).

Plot, Nos.	MANURES. (Per Acre, per Annum.)	1856.	1857.	1858.	Average of 3 Years.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	82·0	85·1	85·9	84·3
2	Unmanured (duplicate plot)	81·9	87·3	85·5	84·9
	Mean, or Standard Unmanured	81·9	86·2	85·7	84·6
3	2000 lbs. Sawdust	80·7	87·7	84·4	84·3
4	200 lbs. each, Sulphate and Muriate Ammonia	80·0	86·7	84·1	83·6
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	79·6	87·6	83·9	83·7
6	275 lbs. Nitrate of Soda	..	..	84·8	..
7	550 lbs. Nitrate of Soda	..	..	85·8	..
	Mean	80·5	87·0	84·8	84·0
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	80·2	86·7	85·6	84·2
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	80·5	86·8	84·1	83·8
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	79·0	87·0	82·1	82·7
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	77·3	87·2	83·8	82·8
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	79·2	86·8	82·4	82·8
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	78·1	85·9	80·7	81·6
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	86·4	..
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	85·2	..
	Mean	79·0	86·7	83·1	83·0
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	76·1	87·3	84·6	82·6
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	79·6	86·2	82·7	82·8
	SUMMARY.				
	General Means for the Experimental Specimens	79·3	86·8	84·1	83·4
	Mixed Hay from the same Meadow; taken out of the rick December 1858	..	87·2	83·8	..

from the rick of that year (also sampled Dec. 1858) was 83·8. The general characteristics of the produce of the *different seasons*, in regard to its percentage of *Dry matter*, are, therefore, correctly represented in the results given in the Table in reference to the experimental specimens.

The differences in the percentages of Dry matter in the hay, due to different *manuring*, are by no means so great as those due to variation of season or climatic circumstance. Still the general tendency of the influence of characteristic descriptions of manure is clearly discernible. The indications of the coincident comparative conditions of the produce, according to the manure employed, are also consistent.

Up to the period at which the crops were cut, the use of *ammoniacal salts* had the almost invariable effect of giving a produce which contained a somewhat lower proportion of Dry matter, than that grown under otherwise exactly comparable conditions. Such is seen to be pretty uniformly the result, whether we compare the produce by ammoniacal salts alone with that without manure; that with ammoniacal salts and sawdust, with that with sawdust alone; that with ammoniacal salts and mineral manure, with that by mineral manure alone; that with ammoniacal salts sawdust and mineral manure, with that by sawdust and mineral manure alone; or that with the larger amount of ammoniacal salts and mineral manure, with that by the smaller amount of ammoniacal salts and the same mineral manure. A similar result is observed too, in two years out of the three, where ammoniacal salts were used in addition to farmyard manure. The results in the Table, which appear to be exceptional to this generalisation in regard to the influence of ammoniacal manures upon the percentage of Dry matter of the hay taken at a given period of the season, occur in some of the cases with the artificial manures in 1857; and in 1856, in the case where the ammoniacal salts were used in addition to farmyard manure.

Ammoniacal salts which have thus been seen, other things being equal, to give a produce which contains a comparatively low percentage of Dry matter, gave, it should be remembered, also a much increased bulk and weight of hay over a given area; hence, even supposing that the description of the herbage, and the condition of maturity of the plants, were the same where the larger crops were grown with ammoniacal salts, and the smaller ones without them, we should still expect that the larger produce would dry somewhat less, exposed to equal circumstances during the making. But the description of the herbage, and its degree of forwardness, have been seen to vary very much according to the manure employed. The produce grown by ammoniacal salts gave a much larger proportion of Graminaceous plants than that

grown without them. The mere flowering and seeding stems of this Graminaceous herbage, would contain a higher percentage of Dry matter than the leaves and younger shoots. But besides the detached leafy matter, the larger culms grown by the ammoniacal salts, were themselves more luxuriant and succulent, and carried more green leaves and shoots than the smaller ones grown under otherwise comparable conditions, but without the ammoniacal salts.

It is obvious, then, that the percentage of the *Dry matter* in such complex and heterogeneous produce as hay, is dependent on too many coincident causes, to be of itself any unconditional indication of the character, or degree of maturity, of such produce.

The percentages of *mineral matter* and of *nitrogen* in the dry substance of the hay grown by the different manures, will be some further guide as to the comparative degrees of succulence, or maturity, of the produce developed under the different conditions.

Mineral Matter (Ash).

The *mineral matter* was determined by burning to ash the portions of hay which had been dried at 212° F., and reweighed for the determination of the dry matter. The burning was conducted on sheets of platinum placed in cast-iron muffles, heated by coke. Duplicate determinations were always made. The *mean* percentages, only of the two determinations, are given in Table XII.; and the *individual results* are recorded for reference in Tables II., III., and IV., in the Appendix.

In *ripened* produce, such as our crops of corn, the relations of the percentages of *mineral matter* in the dry substance in a series of comparable specimens, are pretty clear indications of the relative degrees of elaboration and ripeness of such produce. Other things being equal, the smaller the percentage of Mineral matter in the dry substance, the more highly elaborated, or the riper, is the specimen. The percentage of *nitrogen* in our ripened corn-crops is affected in a somewhat similar manner. Other things being equal, the lower the percentage of nitrogen in the dry substance, the higher, taking the average of seasons, will be the condition of maturation of the produce.

The like generalisation appears to be more applicable to the composition of the complex and but partially ripened produce, *hay*, than would perhaps have been anticipated.

The hay-season of 1856 was wet and cold, and the produce it yielded contained a very low percentage of dry substance. The hay-seasons of 1857 and 1858 were, upon the whole, much drier and warmer, and, accordingly, the percentages of dry substance in

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE XII.—PERCENTAGES of MINERAL MATTER (Ash) in the HAY (Means of Duplicate Determinations).

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.				Percentages in the Dry Substance of the Hay.			
		1856.	1857.	1858.	Average of 3 years.	1856.	1857.	1858.	Average of 3 years.
	SERIES 1.—Without Direct Mineral Manure.								
1	Unmanured	6·26	5·63	5·70	5·86	7·64	6·61	6·64	6·96
2	Unmanured (duplicate plot)	6·64	5·71	5·56	5·97	8·10	6·54	6·50	7·05
	Mean, or Standard Unmanured	6·45	5·67	5·63	5·91	7·87	6·57	6·57	7·00
3	2000 lbs. Sawdust	6·62	5·64	5·61	5·96	8·20	6·43	6·65	7·09
4	200 lbs. each, Sulphate and Muriate Ammonia	6·44	5·48	5·14	5·69	8·06	6·32	6·11	6·83
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	6·01	5·51	5·33	5·62	7·54	6·29	6·35	6·73
6	275 lbs. Nitrate of Soda	..	..	5·73	..	..	..	6·75	..
7	550 lbs. Nitrate of Soda	..	..	5·38	..	..	..	6·26	..
	Mean	6·38	5·59	5·67	5·79	7·92	6·40	6·45	6·91
	SERIES 2.—With Direct Mineral Manure.								
8	"Mixed Mineral Manure"*	6·92	6·16	6·48	6·52	8·63	7·10	7·57	7·77
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	7·31	6·60	6·47	6·79	9·08	7·60	7·70	8·13
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	6·77	6·28	6·53	6·53	8·58	7·21	7·95	7·91
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	7·03	6·42	6·80	6·75	9·09	7·36	8·11	8·19
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	6·72	6·72	6·68	6·71	8·49	8·49	8·11	8·36
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	6·57	6·42	6·35	6·45	8·41	7·47	7·87	7·92
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	6·40	..	..	..	7·40	..
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	6·52	..	..	..	7·65	..
	Mean	6·89	6·43	6·53	6·62	8·71	7·54	7·79	8·01
	SERIES 3.—With Farmyard Manure.								
16	14 tons Farmyard Manure	7·29	6·51	6·72	6·84	9·58	7·45	7·95	8·33
17	14 tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	7·52	6·45	6·74	6·90	9·45	7·48	8·14	8·36
	SUMMARY.								
	General Means for the Experimental Specimens	6·80	6·15	6·16	6·37	8·58	7·15	7·73	7·82
	Mixed Hay from the same Meadow; taken out of the rick, December, 1858	..	5·58	5·73	..	..	6·40	6·84	..

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

their produce were much higher. Coincidently with the much lower percentage of dry matter in the produce of 1856, there was a considerably higher percentage of Mineral matter in the dry substance of that produce than in that of either 1857 or 1858. Again, the average percentage of dry substance in the hay was lower in the produce of 1858 than in that of 1857 ; and in accordance with this, the average percentage of Mineral matter in the dry substance of the produce of 1858, was higher than in that of 1857. It appears then, that, *comparing season with season*, the general result on this point in regard to hay, is in conformity with that generally observed in the case of more equably ripened produce. That is to say, the lower the condition of elaboration of the constituents of the produce, the lower is the percentage of the Dry substance, and the higher the percentage of the Mineral matter in that dry substance.

So much for the results in regard to the percentage of *Mineral matter* in the hay, as affected by *season*. We turn now, to the influence of *manuring* on the composition of the hay in regard to Mineral matter.

When it is borne in mind—that the proportion of the produce which will consist of Graminaceous, Leguminous, or other herbage, —that the proportion of the respective plants comprised within each of these main classes—that the proportion of each that will be in leaf and culm respectively—and that the condition of maturity at any given time—will vary very considerably according to the manure employed, it will be obvious that the variations in the percentages of Mineral matter, due to manuring, will be the resultants of many coincidently operating causes. On these points it may be observed—that the dry substance of Leguminous herbage contains on the average about $1\frac{1}{3}$rd time as high a percentage of Mineral matter as that of Graminaceous herbage; that the dry substance of the leafy portion of the produce contains a higher percentage than that of the stemmy portion; and lastly, that the riper the produce the lower will be the percentage of Mineral matter in the dry substance. But again, in green and unripened produce more especially, the *percentage* of Mineral constituents, as well as the actual amounts assimilated over a given area of land, are very much affected by the deficiency or liberality of their supply, in available form, within the range of collection of the growing crop.

The Table (XII.) shows that where no mineral manure was employed—and especially where nitrogenous manures were used alone, and the production thus pushed to the extreme limit of the available supplies of the mineral constituents of the soil itself—the percentage of Mineral matter, in the dry substance of the hay, was comparatively low. A somewhat similar result has been

observed in the case of corn-crops grown under similar circumstances. In illustration of the point in regard to the hay, it is seen that, whilst the average percentage of Mineral matter in the dry substance of the specimens grown without mineral manure was 6·91, that, taking the average of the cases where artificial mineral manure was employed, was 8·01. It is true that, in those cases where mineral manure was employed with ammoniacal salts, the *stemmy* produce was somewhat less ripe, and hence, so far, the percentage of Mineral matter in the dry substance would be expected to be comparatively high. On the other hand, the produce in these cases was almost entirely Graminaceous, and the Graminaceous produce itself contained a large proportion of stem to leaf, and both of these circumstances would, other things being equal, tend to a low percentage of Mineral matter in the dry substance. In fact, upon the whole, the evidence is pretty clear, that the lower percentage of Mineral matter in the dry substance of the produce grown without mineral manure, was due to a relative deficiency of available mineral constituents in the soil. The direct influence of the supply of mineral constituents by manure, upon the assimilation of them by this voracious crop, will be further illustrated presently, when speaking of the *composition of the ash* of the produce grown by the different manures.

Where the mineral manures were used alone, more than one-fifth of the produce consisted of Leguminous herbage. Hence, it might be supposed, that the percentage of Mineral matter in the gross produce, or hay, would be higher than where nitrogenous manures were also employed, and the produce was almost entirely Graminaceous. Again, where the mineral was used without the nitrogenous manure, the proportion of the Graminaceous produce that was leafy was much greater than where nitrogenous manures were also used. This circumstance, again, would tend to a high percentage of Mineral matter in the produce grown by the mineral manures alone. But the fact was, that the percentage of Mineral matter in that produce was comparatively low. The result was, doubtless, due to the fact, that a large proportion of this produce by mineral manure alone, was much riper than that grown by the mineral and nitrogenous manures combined.

It appears then, that in the case of the complex and unripened produce—*hay*, the description of the herbage, the character of development, the stage of progress at which the plants are cut, and the supplies within the reach of the growing crop, all have a marked influence upon the percentage of *Mineral matter* in the produce. The effects of different manure, in one and the same season, upon this percentage are, therefore, at least complicated, if not indirect. Nor do the relative percentages among a series of

specimens so clearly indicate the comparative conditions of elaboration and maturation merely, as they generally do in the case of professedly ripened produce.

Constituents of the Ash.

The influence of the artificial supply of mineral constituents upon the total amount of them assimilated by the crop over a given area of land, has been illustrated in Part II. of our Report. The influence of such supply upon their percentage in the dry substance of the produce has now been shown. By the aid of complete analyses of the ashes of the produce of some of the experimental plots, further light will be thrown on the effects of a liberal provision of mineral constituents in the soil on the mineral composition of the crop.

In the first Division of Table XIII. is given the *percentage composition* of the ashes from the produce of five of the experimental plots; in the second Division of the Table the amounts of each of the several mineral constituents in the average annual *total produce* per acre on each of the plots; and in the third Division the *increase* in the amounts of the several mineral constituents obtained, per acre, in the crop, under the influence of the different manures.

The plots selected were—the unmanured; the one with ammoniacal salts alone; the one with mixed mineral manure alone; that with the mixed mineral manure and the smaller amount of ammoniacal salts; and that with the mixed mineral manure and the larger, or double amount of ammoniacal salts. In the case of each of the 5 plots an equal mixture of the ash of its produce in each of the three years was operated upon. In this way the average effect of each condition of manuring upon the mineral composition of the crop is taken over a three-years' continuance of that condition.

The ash-analyses were made in the Rothamsted laboratory, by Mr. Robert Warington, jun.; and we are glad to take this opportunity of expressing our full confidence in the accuracy of his results.

The facts which the figures in the Table disclose are very interesting. But our comments on them must be very brief, and be confined to their practical bearings.

It has been shown in Parts I. and III. of our Paper, that ammoniacal salts alone gave an almost entirely Graminaceous produce, but that that produce was stunted, very dark green, leafy, and not very much more in weight per acre than that without manure. Mineral manures alone, on the other hand, increased the weight of produce somewhat more than the ammoniacal salts alone; but the increase in this case was chiefly Leguminous herbage—the Graminaceous herbage benefiting but little by this

EFFECTS of DIFFERENT MANURES on the MIXED HERBAGE of GRASS-LAND.

TABLE XIII.—PERCENTAGE COMPOSITION of the ASH; and QUANTITIES of the several MINERAL CONSTITUENTS in the Total Produce, and in the INCREASE by MANURE, per Acre.

	Percentage Composition of the Ash.					Mineral Constituents in Total Produce (lbs.).					Mineral Constituents in Increase (lbs.).			
	No Manure.	Ammonia Salts. (82 lbs. N.)	Mineral Manure.	Mineral Manure and Ammonia Salts. (82 lbs. N.)	Mineral Manure and Ammonia Salts. (164lbs.N.)	No Manure.	Ammonia Salts. (82 lbs. N.)	Mineral Manure.	Mineral Manure and Ammonia Salts. (82 lbs. N.)	Mineral Manure and Ammonia Salts. (164lbs.N.)	Ammonia Salts. (82 lbs. N.)	Mineral Manure.	Mineral Manure and Ammonia Salts. (82 lbs. N.)	Mineral Manure and Ammonia Salts. (164lbs.N.)
Peroxide of Iron	0·13	0·12	0·31	0·45	0·52	0·2	0·3	0·7	1·9	2·4	0·1	0·5	1·7	2·2
Lime	14·98	13·85	13·38	9·60	8·65	23·7	31·0	32·4	41·7	39·8	7·3	8·7	18·0	16·1
Magnesia	4·14	4·70	3·70	3·41	3·98	6·6	10·5	9·0	14·8	18·3	3·9	2·4	8·2	11·7
Potash	20·40	17·09	29·77	28·08	28·89	32·3	38·2	72·2	121·9	132·9	5·9	39·9	89·6	100·6
Soda..	8·43	10·31	4·58	7·05	8·49	13·3	23·0	11·1	30·6	39·0	9·7	−2·2	17·3	25·7
Phosphoric Acid	4·86	4·64	6·67	6·30	5·97	7·7	10·4	16·2	27·4	27·5	2·7	8·5	19·7	19·8
Sulphuric Acid	6·09	7·56	7·78	6·27	5·71	9·6	16·9	18·9	27·2	26·3	7·3	9·3	17·6	16·7
Chlorine	6·22	14·66	6·52	16·49	19·93	9·8	32·8	15·8	71·6	91·7	23·0	6·0	61·8	81·9
Carbonic Acid ..	5·62	3·21	6·63	1·87	1·73	8·9	7·2	16·1	8·1	7·9	−1·7	7·2	−0·8	−1·0
Silica	25·91	21·17	18·82	18·57	15·89	41·0	47·3	45·6	80·6	73·1	6·3	4·6	39·6	32·1
Sand	1·41	1·95	0·82	2·84	2·98									
Charcoal	3·19	4·08	2·54	3·04	2·13									
	101·38	103·34	101·52	103·97	104·87									
Deduct O = Cl. *	1·40	3·31	1·47	3·72	4·50									
Totals	99·98	100·03	100·05	100·25	100·37	153·1	217·6	238·0	425·8	458·9	64·5	84·9	272·7	305·8

* In the absence of knowledge which chemistry does not supply, as to the state of combination, either in the plant itself or in the ash, of the several constituents determined in a plant-ash, it is considered far better to make no assumptions on the point. It is, moreover, far more convenient, both for the comparison of the composition of one ash with that of another, and for the purposes of any calculations with a practical view, to represent the whole of the sodium and potassium as soda and potash; instead of part as such and part as chlorides, as is frequently done when chlorine is present. This method, of course, requires the deduction from the sum of the constituents, of an amount of oxygen equivalent (chemically) to the total chlorine.

manure, excepting in forwardness and seeding tendency. But the mixture of the two manures—ammoniacal and mineral—gave an enormous increase of crop, and the amount of mineral constituents taken off an acre of land, under the influence of the combination, was nearly twice as great as that in the crop by either of the manures used separately. It was quite obvious, that where the *ammoniacal salts* were used alone, the available supply of some of the necessary *mineral* constituents fell short of the amount required for a more abundant crop. It was equally clear, that where the *mineral manures* were used alone, there was a deficiency of *nitrogen* available for the increased growth of the Graminaceous herbage. The results in the Table show that it was chiefly for its supply of *potash*, and next for that of *phosphoric acid*, that the mixed mineral manure was so efficacious in increasing the growth of the *grasses*, when there was a sufficiency of available *nitrogen* within the soil. They also point to a probable deficiency of soluble *silica* in the case of the heavier crops.

To turn to the figures in the Table: the most striking point of contrast afforded by the view of the results of the five analyses given side by side, is the very great increase in the percentage of *potash*, wherever the mineral manure containing it was employed. There is at the same time always a diminution either in the actual percentage of soda, or in its proportion to that of the potash, or in both these points of view. This was the case, notwithstanding that soda as well as potash was liberally supplied in the mineral manure. The preference of the growing plants for potash rather than soda is sufficiently manifest. And judging from the analogy of other crops it may almost certainly be concluded that, if all the plants of the hay had been allowed to fully ripen, the ash would then have contained but very little soda, if any at all. The increase in the percentage of *potash* in the ash, where it was supplied in manure, is at the expense of the lime and magnesia, though these constituents were also supplied in the mixed mineral manure. In fact the ash both of the produce without manure, and of that by ammoniacal salts alone, gave a somewhat higher percentage of both lime and magnesia than even where the mineral manures alone were used, and the produce contained so much Leguminous herbage, the ash of which is richer in lime and magnesia than is that of the Grasses proper. The percentage of lime more particularly, was still further reduced, when the ammoniacal salts were mixed with the mineral manure, by which the growth of the Grasses, demanding so much potash, was so much increased.*

* It is seen that wherever the ammoniacal salts were employed, which consisted of a mixture of the sulphate and hydrochlorate, the amount of *chlorine* in the

The percentage of *phosphoric acid*, as well as that of potash, increases notably, though not in so great a degree, where the mineral manure containing it was used.

The percentage of *sulphuric acid* in the ash is pretty uniform throughout, though it was supplied largely both in the ammoniacal salts and in the mixed mineral manure. Whether or not, the whole of the sulphuric acid found, existed *as such* in the plant, in combination with bases, or whether, on the other hand, there has been any loss of it, or of sulphur in some form, during the incineration, may be a question. It is, at any rate, worthy of remark how very much larger is the proportion of *chlorine* found in the ash of this succulent produce wherever it was used in manure, notwithstanding that this substance (chlorine) may be supposed to be in a far less degree than sulphur or sulphuric acid, if at all, essential to the elaboration of the final products of the plants.*

Carbonic acid is seen to be in the largest proportion in the produce grown without manure, and in that by mineral manures alone. The Carbonic acid is the product of the incineration of some other organic acid. Its comparatively large amount in the ash of the produce of the two plots mentioned is due to the Leguminous and other non-Graminaceous herbage, occurring in large proportion on those plots. The ash of such herbage (the non-Graminaceous) contains, indeed, little or no silica, and frequently a great deal of Carbonic acid due to salts of organic acids.

The percentage of *silica* is, nevertheless, much higher in the ash of the produce grown without manure than in that grown by any of the artificial manures now in question. The percentage of *silica* in the ash is the less where the produce of the Graminaceous herbage—which so peculiarly requires it—is the greater. And where the total Graminaceous herbage was thus the greater, it was also in the larger proportion in flowering and seeding stem; and as the stem increases, so, when not in defect, does the proportion of *silica*. It is true that where the Graminaceous produce was so large, and the proportion of it that was in flowering and seeding stem was also large, those stems were not so

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ash is very much increased. This constituent, like soda, is found only seldom, or in small quantity, in the ash of perfectly-ripened vegetable produce. It probably serves more as a vehicle of bases, than as an essential constituent of any of the final products of the organism. Were we to exclude it in all cases from these ash analyses, the percentage of potash would be higher where the ammoniacal salts were used with the mineral manure, and the grasses were so much developed, than where the mineral manure was used alone.

* The fact, that in such highly siliceous ashes the amounts of chlorine should not only in some cases be very large, but that the variations in amount should have such very obvious connection with the manurial conditions supplied, is quite in accordance with the experiments of Mr. Way, showing that a loss of chlorine need seldom be feared when the process of incineration is carefully conducted.

ripe as were those of the smaller Graminaceous crops; and it is as the Graminaceous plants progress to ripeness, that their ashes increase so much in percentage of *silica.* It would appear from these considerations, that there was a deficient supply of *available silica* for the greatly-increased growth. But a better view of the probable mineral requirements, or deficiencies, of the crop, will be gained by attention to the actual or increased amounts of the several constituents in the *acreage produce* under the different manuring conditions, as shown in the second and third Divisions of the Table (XIII.).

By the use of *ammoniacal salts alone*, the amount of total mineral constituents taken off in the crop is about 1½ time as much as without any manure at all. From the obvious limit that there was to the Graminaceous increase by ammoniacal salts alone, it is assumed that, in the case of some of the mineral constituents of the soil, its supplies were drained to the utmost that the range of distribution of the underground feeders of the plant would permit. Supposing this to be the case, it is seen that the gain in both *potash* and *silica* was proportionally less than that of any other important constituent. But, as soon as potash is added in manure, even though without ammoniacal salts, the acreage amount of it in the crop is increased in larger proportion than that of any other important mineral constituent, except phosphoric acid. The *silica*, which was not supplied in the manure, was comparatively but little increased in the produce. When the ammoniacal salts as well as mineral manure were employed, the amount of *potash* in the acreage produce was nearly twice as much as when the mineral manures were used alone; and it was from 3 to 4 times as much as when no manure at all, or ammoniacal salts alone, were employed. Under the same circumstances, the acreage amount of *phosphoric acid* increased in almost an equal degree. So also did that of the *sulphuric acid.* The *silica* even, was about doubled; though there was no supply of it in manure. And, lastly, the *magnesia*, but especially the *lime* (though both were supplied in the manure) increased in very much less acreage amount than the potash.

From the whole it appears, that the much less acreage produce of hay, when the ammoniacal salts were used alone, than when they were used in conjunction with the mixed mineral manure, was due to a deficiency of available *potash* and *phosphoric acid* within the range of the roots of the crop. It also appears probable, that there was a relative deficiency of available *silica*, notwithstanding that the range of collection of the roots of the crop would be considerably increased where the ammoniacal salts and the non-siliceous mineral constituents were employed. It is true that the *acreage* yield of Silica was considerably increased where the

larger crops were grown; though it was so not at all commensurately with either the potash or the phosphoric acid. How far the increased amount of Silica, such as it was, was due to its being liberated in available form by the chemical action of the constituents of the manures employed, or how far only to the increased distribution and range of collection of the roots of the more actively growing crop, we are not able to decide.

To call to mind even more clearly than by the above statements how great is the drain upon the soil, more particularly of potash, phosphoric acid, and of silica, by a heavy hay-crop, it will be useful to quote here a few figures from the Table.

Whilst the unmanured produce contained only $32\frac{1}{3}$ lbs., and that by ammoniacal salts alone only $38\frac{1}{4}$ lbs. of *potash*, that grown by the mineral manure alone (supplying potash) contained $72\frac{1}{4}$ lbs., that by the mineral manure and smaller amount of ammoniacal salts nearly 122 lbs., and that by the mineral manure and the larger amount of ammoniacal salts nearly 133 lbs. of potash, per acre annually.

The *phosphoric acid* was increased from about $7\frac{3}{4}$ lbs. per acre per annum without manure, to scarcely $10\frac{1}{2}$ lbs. with ammoniacal salts alone, to $16\frac{1}{4}$ lbs. with mineral manure alone, and to about $27\frac{1}{2}$ lbs. by the mineral manure and ammoniacal salts together.

The *silica* amounted to 41 lbs. per acre per annum in the produce without manure, to $47\frac{1}{3}$ lbs. in that by ammoniacal salts alone, to nearly $45\frac{2}{3}$ lbs. in that by mineral manure alone, to $80\frac{2}{3}$ lbs. in that by the mineral manure and the smaller amount of ammoniacal salts, and to a little more than 73 lbs. in that by the mineral manure and the larger amount of ammoniacal salts.

We have already prominently called attention to the fact that the hay-crop, both from the large amount of mineral constituents it generally carries from the land, and from the generally more inadequate return of them by the home or other manures, is liable to be much more exhausting to the soil than the rotation crops of a farm. It has been stated, too, that *potash* was perhaps the constituent most likely first to show a deficiency. These ash-analyses, and the discussion to which they have led, cannot fail to impress upon the mind of the farmer still more forcibly the necessity of a due return to the land, at least of *potash* and *phosphoric acid*, if not even of available *silica* (which would be accomplished by farmyard-manure), if he would hope to obtain anything like maximum crops of hay, year by year, by the aid of artificial nitrogenous manures.

It has just been seen how very variable is the composition of the *ash* of the mixed herbage of meadow-land according to the *manure* employed. It has before been shown that the composi-

tion of the total mixed produce, or *hay*, varied very much according to *season*—both in regard to the percentage of Dry substance, and to that of the Mineral matter in that Dry substance. It will also presently be seen that the percentages of total Nitrogenous compounds likewise varied very much according to *season.* The *composition of the ash* does not, however, appear to be so much affected by variation in *season* as from the influence of the latter on the composition of the hay in other points of view might have been anticipated.

The much less effect of variation in *season*, than in *manuring*, on the composition of the ash of the experimentally-grown hay, is illustrated by the results given in Table XIV., which now follows:—

TABLE XIV.—Showing the COMPOSITION of the ASHES of MEADOW-HAY grown Experimentally in different Seasons.

	Mixed Ashes of the Produce by 16 different Manures in each Year.			
	1856.	**1857.**	**1858.**	Calculated Mean **(1856-7-8).**
Peroxide of Iron	0·14	0·33	0·25	0·24
Lime	13·02	12·13	11·92	12·36
Magnesia	3·59	3·93	3·97	3·83
Potash	26·83	26·43	25·26	26·17
Soda	6·40	7·45	9·58	7·81
Phosphoric Acid	5·59	5·68	5·52	5·60
Sulphuric Acid	6·02	7·14	7·18	6·78
Chlorine	11·37	12·15	12·25	11·92
Carbonic Acid	3·37	2·74	2·73	2·95
Silica	22·28	19·93	20·23	20·81
Sand	2·15	2·89	2·29	2·44
Charcoal	2·22	2·22	2·17	2·20
	102·98	103·02	103·35	103·11
Deduct O = Cl *	2·56	2·74	2·76	2·69
Totals	100·42	100·28	100·59	100·42

* See note at foot of Table XIII.

In the first column of the Table is given the composition of an equal mixture of the ashes of the produce from all the experimental plots in 1856; in the second column, the composition of a similarly mixed ash from the produce of all the plots in 1857; and in the third column, the composition of the mixed ash from all the plots in 1858. The fourth column gives the calculated mean of the three analyses.

The uniformity in the composition of the three mixed ashes,

representing as they do the percentage mineral composition of the produce of three very different seasons—the characters of which differed so widely in several other respects—is somewhat remarkable. The differences are indeed too slight to justify the deduction from them of any very defined conclusions. Still, it may be observed, that the tendency of the variations is to show a scarcely maintained, and in some cases an even diminished proportion, of those constituents which may be considered the most characteristic of the hay crop, when it is supplied liberally with all the necessary mineral constituents. Thus, the proportion of phosphoric acid is about equal in the three seasons, whilst that of the lime, the potash, and the silica, show a tendency to decrease from year to year. The carbonic acid too, which is characteristic of the ash of the non-graminaceous part of the herbage, also diminishes somewhat from the first to the third year. On the other hand, the soda and the chlorine—constituents the most of all characteristic of crude and succulent growth—increase very obviously in their proportion in the ash from year to year.

Upon the whole then, these results, comparatively slight as the differences are, still indicate, as did those which have gone before, that there was a probable relative deficiency of *lime*, *potash*, and *silica*;—especially of the latter two.

With regard to the results given in the fourth column attention may be called to the fact, that the figures represent the mean composition of the ash of specimens of hay grown under sixteen different manuring conditions, in each of the three widely differing seasons. The results may therefore be taken as showing the average mineral composition of the mixed herbage grown under a great variety of circumstances.

Nitrogen.

For the information of the chemical reader it may be mentioned, that the *nitrogen* in the hay, as given in the Table, was determined by burning with soda-lime, and estimating by the volumetric method. Duplicate determinations were always made. The individual results are given for reference in Tables V., VI., and VII., in the Appendix. The *mean* results only, are given in Table XV. on the next page; and these will be in sufficient detail for the purpose of our illustrations. The *nitrogen* was thus determined, in the hay from every one of the experimental plots, in each of the three years of the experiments. The figures in the first set of four columns (Table XV.) represent the percentages of Nitrogen in the *fresh hay*—that is, in the condition in which it was carted from the land. The figures in the second Division represent the percentages in the *Dry substance* of the hay.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

TABLE XV.—PERCENTAGES of NITROGEN in the HAY (Means of Duplicate Determinations).

Plot, Nos.	MANURES (Per Acre, per Annum).	Percentages in the Hay as taken from the Land.				Percentages in the Dry Substance of the Hay.			
		1856.	1857.	1858.	Average of 3 years.	1856.	1857.	1858.	Average of 3 years.
	SERIES 1.—Without Direct Mineral Manure.								
1	Unmanured	1·68	1·29	1·40	1·46	2·05	1·52	1·63	1·73
2	Unmanured (duplicate plot)	1·79	1·43	1·34	1·52	2·18	1·64	1·57	1·80
	Mean, or Standard Unmanured	1·73	1·36	1·37	1·49	2·11	1·58	1·60	1·76
3	2000 lbs. Sawdust	1·67	1·38	1·41	1·49	2·07	1·57	1·67	1·77
4	200 lbs. each, Sulphate and Muriate Ammonia	1·57	1·55	1·65	1·59	1·96	1·78	1·96	1·90
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·59	1·49	1·56	1·55	1·99	1·71	1·86	1·85
6	275 lbs. Nitrate of Soda	..	..	1·68	..	..	..	1·98	..
7	550 lbs. Nitrate of Soda	..	..	1·71	..	..	..	1·99	..
	Mean	1·64	1·44	1·56	1·55	2·03	1·66	1·84	1·84
	SERIES 2.—With Direct Mineral Manure.								
8	"Mixed Mineral Manure"*	1·67	1·51	1·40	1·53	2·09	1·74	1·64	1·82
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	1·77	1·48	1·39	1·55	2·21	1·71	1·65	1·86
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	1·23	1·18	1·25	1·22	1·55	1·36	1·52	1·48
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·26	1·11	1·17	1·18	1·64	1·27	1·40	1·44
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	1·47	1·33	1·35	1·38	1·85	1·55	1·64	1·68
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	1·49	1·62	1·71	1·61	1·68	1·88	2·12	1·96
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	1·52	..	..	..	1·76	..
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	1·32	..	..	..	1·55	..
	Mean	1·48	1·37	1·39	1·41	1·86	1·58	1·66	1·70
	SERIES 3.—With Farmyard Manure.								
16	14 Tons Farmyard Manure	1·35	1·31	1·18	1·28	1·77	1·50	1·40	1·58
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	1·62	1·08	1·27	1·32	2·04	1·26	1·53	1·61
	SUMMARY.								
	General Means for the Experimental Specimens	1·53	1·37	1·43	1·44	1·93	1·58	1·70	1·74
	Mixed Hay from the same Meadow, taken out of the rick December, 1858	..	1·33	1·16	..	..	1·53	1·38	..

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

It will be found that the percentage of *nitrogen* in the Dry substance, of such heterogeneous and irregularly ripened produce as hay, is, like that of the mineral matter, contingent upon many coincident circumstances. Still, the results will show, as already alluded to, that, other things being equal, the lower the condition of maturation of the produce the higher will be the percentage of Nitrogen, and *vice versâ*.

In accordance with this general observation, the Table shows that the season which gave the produce yielding the lowest average percentage of Dry substance, and the highest average percentage of Mineral matter in that dry substance (1856), gave also a produce containing a higher percentage of *nitrogen* in its dry substance than that of either of the years of higher condition of the hay. Conversely, the second season (1857), the produce of which showed the highest average percentage of dry matter, and the lowest average percentage of mineral matter in that dry substance, gave, at the time of cutting, a hay which contained the lowest average percentage of Nitrogen in that dry substance. As between the produce of one season with that of another, then, the general result was, that the more matured the condition of the hay, the lower was the percentage of Nitrogen in its dry substance. This is in general accordance with what we have elsewhere shown to obtain in the case of ripened crops—wheat and barley. It is true, that in the case of the hay-crop, the object is not a fully ripened produce. There is, therefore, of course, a limit below which a depreciation in the percentage of Nitrogen, the result of over-ripening, will be a disadvantage. At the same time we believe that, comparing the produce of hay of one season with that of another, each cut at its proper stage of progress, that which has the lower percentage of Nitrogen in its dry substance will, taking the average of seasons, have its constituents in the better condition of elaboration, and be, therefore, a better food for animals.

The variations in the percentage of Nitrogen in the hay within one and the same season, according to the *manuring*, are very marked and interesting.

Taking the average result of the three seasons, the produce grown on the plot manured with ammoniacal salts alone, contained a much higher percentage of Nitrogen in its dry substance than did that grown without manure. Again, the produce grown by ammoniacal salts and sawdust gave a higher percentage of Nitrogen than that grown by sawdust alone. When the ammoniacal salts were thus supplemented to the unmanured, or to the merely sawdusted conditions, the supply of Nitrogen was in considerable relative excess; as was shown by the greatly increased produce when the mixed mineral manure was superadded.

Under these circumstances, the percentage of the deficiently-provided Mineral constituents was comparatively low, whilst that of the relatively excessively supplied Nitrogen was considerably increased. The percentage of Nitrogen was thus increased, notwithstanding that the produce was almost entirely Graminaceous where the ammoniacal salts were used; whilst, where they were not employed, it contained a notable proportion of Leguminous herbage, the percentage of Nitrogen in which is generally about twice as high as in purely Graminaceous produce. The high percentage of Nitrogen in the produce grown by ammoniacal salts without mineral manure was, therefore, due to an increased percentage of it in the Graminaceous herbage. This highly nitrogenised Graminaceous produce consisted, it will be remembered, in very large proportion of *leaf;* it was stunted in growth; and was of a very dark green colour compared with the produce where there were larger crops.

The mixed mineral manure used alone, or in conjunction only with sawdust, gave a produce which contained a higher percentage of Nitrogen than either that grown without manure or with sawdust alone. The percentage of Nitrogen under these conditions was nearly as high as where the ammoniacal salts, or the ammoniacal salts and sawdust (without mineral manure), were used, which gave the stunted, dark green produce, above referred to. But the high percentage of Nitrogen in the produce now under consideration, namely, that grown by mineral without nitrogenous manure, was not due to a high percentage in the Graminaceous part of it. It was due to the fact, that the produce grown under these conditions contained a large proportion of Leguminous herbage, the percentage of Nitrogen in which is, as above stated, generally about twice as high as that in purely Graminaceous hay.

It has been seen, then, that the mineral manure alone gave a produce containing a high percentage of Nitrogen by increasing the proportion in it of the highly nitrogenous Leguminous herbage. It has also been seen, that the use of ammoniacal salts alone, mineral constituents being in defect, gave a stunted Graminaceous produce, also with a considerably increased percentage of Nitrogen. The addition of ammoniacal salts, when there was at the same time a liberal provision of mineral constituents, gave a very different result both as to the character and amount of the crop, and as to the percentage of its Nitrogen.

If we compare the composition of the produce manured with both ammoniacal salts and the mineral manure, with that grown by the mineral manure alone, or again, if we compare the produce by ammoniacal salts, sawdust, and mineral manure, with that by the sawdust and mineral manure without the ammoniacal

salts, the Table shows that, in both cases, the percentage of Nitrogen in the produce was considerably lower where the ammoniacal salts were employed than in the comparable instances without them. This lower percentage of Nitrogen in the hay, by the addition of ammoniacal salts to mineral manure, was partly due to the fact, that the produce grown by the mineral manure without the ammoniacal salts, contained so large an amount of the highly Nitrogenous Leguminous herbage, whilst that grown with ammoniacal salts in addition, was almost entirely Graminaceous. But the percentage of Nitrogen in this Graminaceous produce grown by ammoniacal salts together with a liberal supply of mineral constituents, was also very much lower than that in the equally Graminaceous produce where the nitrogenous supply was in excess; that is to say, where the ammoniacal salts were used without the mineral manure. Thus, taking the average of the three years, the percentage of Nitrogen in the dry substance of the hay grown by ammoniacal salts alone, was 1·9; whilst that in the dry substance of the produce grown by the same amount of ammoniacal salts, but in conjunction with the mineral manure, was only 1·48. This produce grown by the nitrogenous and mineral manure combined, was about $1\frac{2}{3}$ time as great as that grown by the use of ammoniacal salts alone; it was of a far lighter, and more lively green colour whilst growing; it was far more luxuriant; and it gave a much larger proportion of flowering and seeding stem. Such were the comparative characters of the produce, which contained much the lower percentage of Nitrogen. The higher percentage of Nitrogen in the produce grown by the ammoniacal salts without the mineral manure was, therefore, coincident with a much smaller yield of hay, with a much less luxuriance of growth, and with a much larger proportion of leafy produce. In fact, in the case of hay, as in that of the ripened cereal grains, a relatively low percentage of Nitrogen (within certain limits) is, in cases comparable on the point, more likely to be associated with a relatively high, than with a relatively low condition, and degree of elaboration, of the constituents; and it is also more likely to be the result of moderately luxuriant, than of either stunted or over-luxuriant growth.

The points last referred to, are aptly illustrated by a comparison of the characters and nitrogenous percentage of the hay grown by the double amount of ammoniacal salts with the mineral manure, with those of the produce grown by the smaller amount of ammoniacal salts and the same mineral manure. The average percentage of Nitrogen in the dry substance of the scarcely too heavy or luxuriant produce grown by the mineral manure and the smaller amount of ammoniacal salts, was only 1·48; whilst,

that in the dry substance of the over-luxuriant, unevenly-ripened, and laid and damaged produce, grown by the same mineral manure and the double or excessive amount of ammoniacal salts, was 1·96. It will not be doubted, that the higher percentage of Nitrogen was, under these circumstances, coincident with a more crude and less favourable condition of the constituents of the hay. It has been shown experimentally by Professor Voelcker, that succulent plants may contain a part of their nitrogen in the condition of ammoniacal salts; and Professor Sullivan has more recently called attention to the apparently frequent occurrence of both ammonia and nitric acid in the sap of plants. We had too, ourselves, long since pointed out, that turnips in which the percentage of Nitrogen was raised beyond a comparatively low amount by means of highly nitrogenous manures were, weight for weight, of less feeding value—indeed they were sometimes even purgative and injurious—than those having a far lower percentage of Nitrogen, but which were in a less crude and succulent, and a more highly elaborated condition.*

Attention should be called to the fact, that the produce grown by *nitrate of soda* alone, like that grown by ammoniacal salts alone, contained a much higher percentage of Nitrogen, than that grown without manure.† Again, the addition of mineral manure to the nitrate of soda, by which the crop was considerably increased, gave a produce containing a lower percentage of Nitrogen than that grown by nitrate of soda alone.

Before leaving the results of Table XV., it may be observed that, *taking the average of the three seasons*, the addition of ammoniacal salts to *farmyard manure*, gave a produce containing a slightly higher percentage of Nitrogen. In the second season, however, which was the one of the highest dryness and maturation of the hay, at the time of cutting, a contrary result was obtained.

From the whole of the results in regard to *nitrogen*, it would appear, that a *high percentage* is by no means a safe indication of relatively high feeding quality. In fact, in succulent and unripened produce more particularly, it is an uncertain indication even of high amount of elaborated nitrogenous vegetable compound.

Woody Fibre.

The constituent of vegetable food-stuffs, to which the term "*woody fibre*" is frequently given, is that portion which remains

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* 'Jour. Roy. Agr. Soc. Eng.,' vol. x. (1849), pp. 306–315 inclusive.

† As the amount of nitrogen in the hay grown by the *nitrate of soda*, was determined by combustion with soda lime, and estimation as ammonia by the volumetric method, the high amount recorded in the Table could not be due to undecomposed nitric acid or nitrate.

undissolved after the application of such solvents as are supposed to remove all the other vegetable compounds—namely, the nitrogenous substance, the fatty matter, the starch, the sugar, the gum, the extractive matters, &c. The substance so remaining generally retains, however, a certain amount of mineral matter, the quantity of which is determined by the incineration of the fibre. The attainment of certain results in regard to the amount of this so-called "woody-fibre" is, however, in practice, not a very easy matter. It is seldom that two experimenters have adopted the same methods for its quantitative estimation. And, although it is comparatively easy to determine whether or not the product of the process still retains some of the other matters enumerated above, it is by no means so easy to settle whether or not any portion of the substance which it is intended to include under the term Woody-fibre, has itself been rendered soluble and removed. For the results we have to lay before the reader under this head, as well as for those relating to the Fatty matter, to which we shall refer further on, we are indebted to Mr. Thomas Segelcke, of Copenhagen, who kindly undertook this part of the investigation whilst staying in the Rothamsted laboratory.

It would be out of place to go elaborately into the question of method here; and it is the less necessary as Mr. Segelcke will probably publish in detail on this point elsewhere. It may be mentioned, however, that he in vain tried to get results which corresponded with one another when using the different methods that have been recommended. In fact, constancy of result seemed to be only attainable, when solvents of a constant strength were employed, for a fixed period of time, and at a given temperature. The necessity for observing fixed time and temperature, has been insisted upon by Millon; and the strength of solvents which Mr. Segelcke adopted in the analysis of the hays, as giving pretty uniform results, was very much the same as recommended by M. Peligot.

The method by which the results given in the Table were obtained, was briefly as follows. About 10 grammes of the finely ground hay were first fully dried at a temperature of 212° F. The substance was next digested for three-quarters of an hour at a temperature, as nearly as it could be maintained, of 180° F., in 150 septems* of sulphuric acid, composed of one part, by volume, oil of vitriol, and two parts, by volume, water.†

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* A septem measure is that of $\frac{1}{1000}$th of a pound avoirdupois, or 7 grains, of water.

† The above is the strength of acid recommended by M. Peligot. In subsequent investigation Mr. Segelcke has found, that results of which the duplicates were much more closely agreeing, and which still ranged very close to those recorded in the Table and obtained by the method described in the text, could be insured by using a weaker acid, but at a higher temperature. So far as his experiments have yet proceeded, the strength of acid which he has found to be the

After this digestion, the whole was diluted with hot water, filtered, and the insoluble matter well washed with hot water. At this stage the product retained several per cent. of nitrogenous substance, and a considerable amount of other matters which were dissolved in the next step of the process. The substance was removed from the filter, and then boiled for half an hour with 600 septems of very dilute caustic soda. The whole was again thrown on a filter and well washed with hot water. A drop of sulphuric acid was, however, added to the wash-water after the main portion of the washings had passed off; and the washing was continued until the water no longer came through acid. The matter was then washed from the filter, dried, and weighed as *woody fibre.* After this treatment, the product still retained 0·1 per cent., or less, of its weight of nitrogenous substance, and some mineral matter; both of which were determined and deducted by calculation.

The individual determinations of this Woody-fibre are given for reference in Table VIII. in the Appendix; and an examination of them will show within what limits the duplicate or triplicate results agree with one another. It is believed that the figures are probably very trustworthy as a comparative series, comparing specimen with specimen as to the respective amounts of Woody-fibre of a given degree of insolubility or induration; but they are pretty certainly too low considered as including the whole of the *cellulose.* At least Mr. Segelcke found that even Swedish filtering paper was somewhat reduced in amount by the second part of the process, namely, the treatment with alkali, though it was not so by the digestion with the sulphuric acid. On the other hand, with any less treatment with the alkali, not only higher results, but inconstant duplicates or triplicates, were obtained; and the product at the same time retained a considerably higher amount of nitrogenous substance.

As already intimated, the *woody fibre* was only determined in the hay of certain plots, namely, those selected for the botanical separations referred to in Part III. It was, however, determined in the produce of those plots, in each of the three years of the experiments. We are enabled, therefore, to trace the effects of both *season* and *manuring* on the percentage of the

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best is, 1 volume of oil of vitriol to 16 volumes of water; the temperature that of the boiling point; and the time of action a quarter of an hour. A great practical advantage of substituting the use of a stronger acid, and a temperature below the boiling point, by a weaker acid and the boiling point, is the ease by which constancy in the latter temperature can be secured. Indeed, the discrepancies, such as they are, between the duplicate and triplicate determinations recorded in the Appendix, Table VIII., Mr. Segelcke attributes mainly to the accidental fluctuations in practice, somewhat above or below his then adopted temperature of 180° F.

more insoluble *woody fibre*—so far as it can be indicated by the results of the method above described. The *means* only, of the two or more determinations made on each specimen, are given in Table XVI. which now follows; and it is these to which we shall confine attention.

The professed object of determining the amount of *woody-fibre* in our food-stuffs, is to acquire some means of judging of their amount of probably indigestible and effete material. Now, it is sufficiently established by the researches of many able investigators, among whom we may mention Mulder, Harting, Boussingault, Millon, Peligot, Mitcherlich, Chevreul, Fremy, Cramer, and Payen, that the substance to which is given the somewhat generic term *woody-fibre*, comprises many modifications, which vary from each other, in physical characters, and in behaviour to solvents, according to age, and other circumstances of their deposition, and to the character and amount of the incrusting matters, and of the injected, or foreign matters, with which they are associated. In fact, some of the modifications which yield most easily to certain chemical solvents, seem to be separated by almost imperceptible lines of demarcation, from the admittedly more digestible starchy bodies. The two series of bodies appear, indeed, to be mutually transformable, not only in the laboratory of vegetable existence, but more or less in that of the chemist also. How then, are we by the chemical analysis of a food, to determine exactly at what point of aggregation, induration, or protection by foreign substances, its Cellular or Woody matter is to be accounted as indigestible, innutritious, and effete? So long as the Cellular substance is in such a condition as to be easily acted upon by chemical solvents, or to be transformable within the plant, we may perhaps venture to assume, that it would not be wholly refractory to the digestive agencies of animals. If, therefore, it be admitted, that the amounts of matter recorded as *woody fibre* in our Table, do not include the more delicate and changeable Cellulose of the vegetable substance examined, they may nevertheless, on that account, the more nearly represent the proportions of the respective hays, that will be necessarily indigestible and effete. In fact, although we do not at all claim that the results do indicate the *total cellulose* of the specimens examined, we still believe, that so far as present experience goes, results so obtained are the best means at command for the purpose of comparing the specimens one with another, in regard to the relative proportion in each of the more refractory Cellular matter. And, so far as the substance which resists the action of solvents employed in the degree above described, may be found to be really indigestible and effete, a large relative proportion would in this point of view be objectionable. At the same time, it must be

Experiments with Different Manures on Permanent Meadow Land.

Table XVI.—Percentages of Woody Fibre in the Hay (Means of Duplicate Determinations).

Plot, Nos.	MANURES. (Per Acre, per Annum.)	1856.	1857.	1858.	Average of 3 Years.
	Percentages in the Hay as taken from the Land.				
1	Unmanured	24·5	22·9	22·9	23·4
4	200 lbs. each, Sulphate and Muriate Ammonia	24·8	23·1	22·9	23·6
8	"Mixed Mineral Manure" *	24·0	23·0	25·0	24·0
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia ..	25·5	25·3	24·1	25·0
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia ..	25·6	24·2	23·6	24·5
16	14 tons Farm-yard Manure	23·7	25·8	24·5	24·7
17	14 tons Farm-yard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia ..	23·6	25·0	24·3	24·3
	Means	24·5	24·2	23·9	24·2
	Percentages in the Dry Substance of the Hay.				
1	Unmanured	29·9	26·9	26·6	27·8
4	200 lbs. each, Sulphate and Muriate Ammonia	31·0	26·6	27·2	28·3
8	"Mixed Mineral Manure"	30·0	26·5	29·2	28·6
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia ..	32·3	29·0	29·4	30·2
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia ..	32·8	28·2	29·3	30·1
16	14 tons Farm-yard Manure	31·2	29·6	29·0	29·9
17	14 tons Farm-yard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia ..	29·7	29·0	29·4	29·4
	Means	31·0	28·0	28·7	29·2

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

borne in mind, that a certain proportion of this otherwise useless and effete matter, is absolutely essential to give bulk, and to aid the digestion of the other constituents of the food, especially of our ruminant animals.

With these brief observations on the character and relationships of the substance, the amounts of which, in the respective hays, are recorded in the Table, attention may now be directed to the results there given.

In the upper portion of Table XVI., the percentages of *woody-fibre*, or more properly of comparatively indurated Cellular matter, in the *fresh hay* are given; and in the lower Division, the percentages in the *Dry substance* of the hay. The latter indicate the most clearly the differences in the composition of the vegetable substance of the hay. Comparing the produce of one season with that of another, the percentage of this comparatively insoluble Woody-fibre is, on the average, considerably the highest in that of the wet, cold, and ungenial season 1856, and the lowest in that of 1857. It will be remembered that the produce of 1856, which shows the largest proportion of comparatively refractory Woody matter in its Dry substance, gave a very low percentage of Dry substance; but high percentages of both Mineral matter and Nitrogen (in a questionable degree of elaboration), in that Dry substance. And conversely, the produce of 1857, which now gives the lowest proportion of such Woody fibre in its Dry substance, gave the highest proportion of Dry substance and the lowest proportion of Mineral matter and Nitrogen, in that Dry substance.

It might perhaps not have been anticipated, that the season which gave the most crude, succulent, and ill-conditioned produce, would at the same time give a vegetable substance containing a high proportion of comparatively indurated cellular or woody matter. In all cases, the specimens were so far dried soon after they were collected, as to leave in them only about 5 per cent., or less, of moisture; and in this condition they were ground and preserved. And, as the Woody-fibre determinations have only recently been made, the produce of 1856 has had some considerable time for change, were it liable to it. Under the circumstances of the preparation and preservation of the specimens, however, it would be difficult to conceive of any changes that would raise the percentage of indurated cellular matter in the remaining substance, to the extent indicated in the Table above that in the produce of the other years. Against the probability of such change, may be noted the fact, that the produce of 1857 which had been preserved for nearly 2 years when examined, gave a *lower* percentage of this Woody-fibre in its Dry substance, than that of 1858 which, of course, had not been preserved so long. On the

other hand, neither do any of our records as to the character of the produce in the several years, or as to the characters of the seasons themselves, lead to the belief that the produce of 1856 was either in such large proportion *stemmy*, or so *forward*, at the time of cutting, as that of the other seasons. Should then, future researches confirm the indications of these results, we should have to adopt the important conclusion, that a crude and succulent produce—a large proportion of whose more soluble constituents exists in a low condition of elaboration—may at the same time have a large proportion of its more fixed constituents in the condition of comparatively indurated and innutritious cellular matter. Or, may it be, that, when there is a low condition of elaboration of some of the more soluble constituents, so large a proportion of these undergo change, as to leave the more fixed Woody matter in larger proportion in the remaining total dry substance?

When the observed variations in the character of the produce are borne in mind, the effects of *manures* upon the relative percentages of the more fixed Woody-fibre in its Dry substance, are more clearly in accordance with what would be expected than are those of *season*. Taking the average result of the 3 years, the Dry substance of the *unmanured* produce, contained a comparatively low percentage of such Woody-fibre. This produce contained a large proportion of non-Graminaceous herbage; a fair proportion was stemmy, but it was backward, and with these characters there is a low percentage of Woody-fibre in the Dry substance. The Dry substance of the produce by *ammoniacal salts alone*, whose Graminaceous stems were comparatively ripe, but which contained a very large proportion of leaf, contained at the same time a comparatively small proportion of the "woody fibre." The produce by *Mineral manures alone* consisted of a good deal of non-Graminaceous herbage, and the Graminaceous herbage comprised a considerable proportion of leaf, though its stems were comparatively ripe. With these characters, the percentage of the "woody fibre" in the Dry substance was comparatively low. Where the *mixed mineral manure and ammoniacal salts were used together*, the produce was, comparatively, somewhat unripe; but it was almost entirely Graminaceous, and in very large proportion stemmy, and coincidently there is a comparatively large proportion of the "woody fibre" in the Dry substance. The produce by *farm-yard manure* was in a still larger proportion stemmy; but it contained also a considerable proportion of non-Graminaceous herbage. The result was, that its Dry substance contained a comparatively high percentage of the "woody fibre," but not quite so high as that where the mineral manure and ammoniacal salts were used, and the produce was more exclusively Graminaceous.

Adopting the experimental indications which have been recorded, as the most trustworthy which in the existing condition of our knowledge on the points in question could be supplied, the result upon the whole would appear to be, that, on the one hand, a generally low condition of elaboration of succulent produce may still be associated with a high proportion of comparatively indurated, and therefore probably innutritious Cellular matter, in its dry substance. On the other hand, comparing the produce by different *manures*, in one and the same season, the more Graminaceous, the riper, and the more stemmy, the higher will be the proportion of the comparatively indurated Woody or Cellular matter.

Fatty Matter.

In the analysis of animal and vegetable food-stuffs, it is usual to estimate as "*Fatty Matter*," that portion which is dissolved out from the dried substance by means of ether. In the case of animal substances, or of ripened vegetable ones, such as grain, the substance so determined does generally represent a fatty matter of high respiratory and fat-forming capacity. Not so, however, in the case of crude, unripened, vegetable produce. In fact, in such produce, the so-called *fatty matter* separated merely by extraction with ether, is largely contaminated with waxy and green colouring matter, a considerable proportion of which passes from the animal in its solid excrements. A relatively large proportion of such impure fatty substance can hardly be regarded, therefore, as an advantage. Still, it is useful to ascertain the amount of such matter, if it be only that, by a careful consideration of the conditions of growth, and other admitted qualities of the hay yielding the larger or the smaller proportions of it, we may be the better able to form a valid decision, whether or not the substance in question is likely really to indicate the high condition of elaboration of the constituents, which a large proportion of *pure fatty matter* might be supposed to do. A further reason for determining the amount of this substance, notwithstanding that we consider it of such doubtful value, is the fact, that this mode of analysis has been adopted with apparent confidence by most of our predecessors; whilst an accurate separation of the several bodies which compose this Ether-extract, would have increased the labour of analysis beyond that which our time enables us to devote to it. Nor, is the quantity of this impure fatty matter in hay so large, as to render the differences in its amount of much importance in any other point of view, than as indicating the general character and condition of the produce.

The method adopted by Mr. Segelcke, in his determinations

of the *crude fatty matter*, was to pass ether through a dried and weighed portion of the finely ground hay, until it came through colourless. For this purpose, he devised an apparatus, by means of which the ether was continuously distilled from the extract, and repassed through the substance. At the end of the first treatment in this way, that is, when the ether passed through colourless, the substance was re-dried in the water bath, and then submitted to a second extraction in the ether-apparatus. The ether was finally distilled from the total ether-extract; and the remaining *green fatty matter* dried in a water bath, until it no longer lost weight.

From what has already been said of the character of the "Fatty matter," the quantity of which in the respective hays, was determined by the methods just described, it would be useless to go into much detail as to the amounts found in the different specimens. It is the less desirable, too, to do so, as the circumstances and extent of its occurrence will be sufficiently brought to light, in taking the summary view of the composition of the different hays, with which we now propose to conclude our Report. The individual determinations of the Fatty matter will be found in Table IX. in the Appendix; and the mean percentages of it are embodied with those of the other constituents in Table XVII., to which attention is next, and lastly, to be directed.

Summary of the Composition of the Hay.

In Table XVII. is given a summary view of the collective composition of the specimens of hay grown in the Third Season (1858), on those plots the produce of which was selected for the botanical separations. In the upper Division of the Table, the percentages of the several constituents *in the fresh hay as carted from the land*, are given. In the middle Division, the percentages in the *Dry substance* of the hay are given. And in the lowest Division, is a summary statement of the general description of the herbage on the respective plots. The means are thus afforded, of considering the chemical composition of the respective hays, in connection with the other known characters of the herbage. The constituents given are—

1st. Nitrogenous substance.
2nd. Fatty matter.
3rd. Woody-fibre.
4th. Other non-nitrogenous vegetable compounds.
5th. Mineral matter.
6th. Total Dry substance.
7th. Water.

A few brief remarks should first be made, as to the character of the several substances represented in the above enumeration.

Nitrogenous substance.—The most practicable and usual mode of getting at an approximate estimate of the total amount of Nitrogenous compounds, in vegetable or animal food-stuffs, is to determine the amount of *nitrogen,* and calculate from it the amount of Nitrogenous substances, on the assumption that they consist of the so-called *proteine compounds.* Adopting this assumption, the amount of Nitrogen has only to be multiplied by 6·3, to give, very nearly, the amount of Nitrogenous proximates that it would represent. This is the method which, from convenience, we have adopted. From what has been said under the head of Nitrogen, however, it will be obvious, that this mode of estimation affords, more particularly in the case of succulent and unripened produce, at best but an uncertain indication of the amount of elaborated and nutritive Nitrogenous compound. The so-calculated Nitrogenous substance may, in fact, not only include a quantity of matter in a low condition of elaboration, but even ammoniacal salts. It will be understood, therefore, with what degree of reservation the recorded amounts of "*nitrogenous substance*" must be taken, as indicating the probable amounts of nutritive proteine compounds.

Fatty matter.—The substance given under the head of Fatty matter, includes, as has been already explained, a quantity of waxy and green colouring matter, and must not be taken therefore as representing pure fatty matter of high respiratory and fat-forming capacity.

Woody-fibre.—It will be borne in mind, that the substance recorded as Woody-fibre, is not supposed to include the whole of the Cellular matter in its various modifications; but only that amount of it which seems to possess a certain fixed degree of persistence, on the application of such solvents as are required to remove the other compounds. It is possible, however, that at any rate the easily changeable, and easily dissolved portions of the Cellular substance, may be amenable to the digestive organs of animals.

Other non-nitrogenous matters.—The substances put down as *other non-nitrogenous matters,* are all those which remain after deducting the "Nitrogenous substance," the "Fatty matter," and the "Woody-fibre," as above defined, and also the "Mineral matter." They comprise probably starch, dextrine, gum, sugar, and certain extractive matters. They will also include so much of the more easily changeable Cellulose, or Cellular matter, as may have been dissolved by the re-agents required to remove all the other matters, in the process adopted for separating and estimating the so-called "Woody-fibre." The characters, and

TABLE XVII.—COLLECTIVE VIEW of the COMPOSITION, and DESCRIPTION, of the MIXED HERBAGE.

CONSTITUENTS.	HAY FROM SELECTED EXPERIMENTAL PLOTS.								Mixed Hay from same Meadow; cut out of rick December, 1858.
		Artificial Manures.				Farmyard Manure.			
	Un-manured. (Plot 1.)	Ammoniacal Salts, alone. (Plot 4.)	"Mixed Mineral Manure." (Plot 8.)	"Mixed Mineral Manure", and Ammoniacal Salts. (Plot 10.)	"Mixed Mineral Manure" and double quantity Ammoniacal Salts. (Plot 13.)	Alone. (Plot 16.)	With Ammoniacal Salts. (Plot 17.)	Mean.	
1.—Composition per Cent. in the Fresh Hay.									
Nitrogenous Substance (N. × 6·3, reckoning 15·875 N. in Nit. Sub.)	8·82	10·39	8·82	7·87	10·77	7·43	8·00	8·87	..
Fatty Matter (Ether Extract)	2·87	3·00	2·55	1·99	2·36	2·48	2·80	2·58	..
Woody Fibre	22·88	22·87	24·97	24·11	23·64	24·51	24·31	23·90	..
Other non-Nitrogenous Vegetable Compounds (Starch, Sugar, Gum, &c.)	45·63	42·70	42·78	41·60	37·58	43·46	40·85	42·08	..
Mineral Matter (Ash)	5·70	5·14	6·48	6·53	6·35	6·72	6·74	6·24	5·73
Total Dry Substance	85·90	84·10	85·60	82·10	80·70	84·60	82·70	83·67	83·80
Water	14·10	15·90	14·40	17·90	19·30	15·40	17·30	16·33	..
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	..
2.—Composition per Cent. in the Dry Substance of the Hay.									
Nitrogenous Substance (N. × 6·3, reckoning 15·875 N. in Nit. Sub.)	10·27	12·35	10·33	9·58	13·36	8·82	9·64	10·62	..
Fatty Matter (Ether Extract)	3·34	3·57	2·98	2·42	2·93	2·93	3·39	3·08	..
Woody Fibre	26·63	27·20	29·17	29·37	29·30	28·97	29·40	28·58	..
Other non-Nitrogenous Vegetable Compounds (Starch, Sugar, Gum, &c.)	53·12	50·77	49·95	50·68	46·54	51·33	49·43	50·27	..
Mineral Matter (Ash)	6·64	6·11	7·57	7·95	7·87	7·95	8·14	7·45	6·84
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	..
3.—Summary Statement of the Description of the Herbage.									
Graminaceous Stems bearing Flower or Seed	50·25	35·91	42·18	72·66	65·08	69·76	64·62	57·21	..
Graminaceous Leafy Produce	25·85	53·20	29·64	24·72	32·27	17·91	15·05	28·38	..
Leguminous Herbage	5·12	2·20	22·89	..	..	3·70	1·78	5·10	..
Miscellaneous Herbage (chiefly weeds)	15·73	6·14	1·71	1·85	1·67	7·05	16·43	7·23	..
Shedded Seeds, and Indeterminate Vegetable Matter	3·05	2·55	3·58	0·77	0·98	1·58	2·12	2·08	..
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	..

the feeding capacity, of the matters grouped together under this head, will probably depend much upon the *condition* of the hay. The worse the condition of the hay, the greater probably will be the proportion of them, which will consist of the ill-defined "extractive matters."

Mineral matter.—The so-designated Mineral matter, is that which remains as *ash*, on the incineration of the hay. It is needless to say that Mineral constituents are essential in the food of animals. In most vegetable foods, however, they generally exist in a larger proportion to the other constituents than they are probably required; and hence their large amount in any food is no criterion of high feeding value. On the contrary, as, in comparable cases, a high percentage of Mineral matter is generally coincident with a low degree of elaboration of the collateral vegetable substances, the smaller percentage among a series of specimens of produce of like description, will most probably be associated with a higher relative feeding capacity.

The proportions of these several constituents, in the hay grown by the different manures, may now be briefly noticed.

The *unmanured* hay contained a notable proportion of Leguminous, and other non-Graminaceous herbage; and the Grasses themselves were stunted. Under these circumstances, the Dry substance of the hay contained a medium percentage of the calculated Nitrogenous compounds, and comparatively a very small proportion of the estimated Woody-fibre. Comparing the produce of one manuring condition with that of another, in one and the same season, a low percentage of indurated Woody-fibre indicates greenness and immaturity. Coincidently with this, the unmanured hay shows a relatively high amount of the impure Fatty matter.

The produce grown by *ammoniacal salts alone*, contained a very high percentage of Nitrogenous compounds, or at least of Nitrogen in some form. This was due, it will be remembered, not to a large amount of Leguminous herbage, but to the condition of the almost exclusively Graminaceous hay, which was stunted, dark green, leafy, and backward. The Dry substance of the hay having these characters, at the same time contained but a small proportion of the comparatively stable Cellular or Woody matter, but the highest amount of any in the series of the green impure Fatty matter. The fact, that the highest percentage of this merely ether-extracted substance, was found in this stunted, dark-green, leafy, and backward produce, may perhaps be taken as some indication, that a relatively high amount of Fatty matter as so determined in succulent produce, does not really represent a high amount of *pure fat* of the high feeding capacity which that substance is assumed to possess.

The produce by *mineral manure alone*, which contained the highest proportion of any, of Leguminous herbage, nevertheless

contained but a moderate percentage of Nitrogenous compounds. This arose from the fact, that the *grasses*, which still constituted by far the largest proportion of the produce, though meagre and stunted in growth, were still comparatively forward. With these characters, the percentage of the so-called Woody-fibre is comparatively high, and that of the impure Fatty matter is comparatively low.

The produce of the plot manured with the *mineral manure and the smaller amount of ammoniacal salts* was bulky, almost wholly Graminaceous, and very stemmy. Consistently, the dry substance of this hay contained a very low proportion of Nitrogenous compounds, the lowest amount of any in the series of the green Fatty matter, and a high percentage of the more fixed Woody-fibre.

The *mineral manure*, together with the *double and excessive amount of ammoniacal salts*, gave an over-luxuriant, succulent, and unevenly ripened, but stemmy and almost exclusively Graminaceous produce. To the former characters may be attributed a very high percentage of the calculated Nitrogenous compounds; and to the latter a somewhat low percentage of the impure Fatty matter, and a high one of the Woody-fibre. The percentage of the green Fatty matter is, however, as would be expected, higher than in the produce grown by the mineral manure and the smaller amount of ammoniacal salts. The remainder, designated as "other non-nitrogenous matters," is less in this over-luxuriant produce than in any of the other cases.

The produce by *farm-yard manure alone*, comprised a moderate proportion of Leguminous and other non-Graminaceous herbage; but, on the other hand, its Graminaceous herbage was in very large proportion in the condition of flowering and seeding stem. Consequently, the Dry substance of the hay contained a low percentage of the Nitrogenous compounds, a low percentage of the impure Fatty matter, and a high percentage of the Woody-fibre.

The hay grown by *farm-yard manure and ammoniacal salts together*, comprised a larger proportion of non-Graminaceous herbage, than that grown by farm-yard manure alone; but, the Graminaceous herbage itself was in as great a proportion stemmy. The result was a hay containing in its dry substance, a considerably higher proportion both of the calculated Nitrogenous compounds and of the impure Fatty matter, and at the same time a high percentage of the Woody-fibre.

The general result, comparing the produce by the different manures in one and the same season, seems to be, that the more the produce is Graminaceous, the more it goes to flower and seed, and the more it is ripened, the higher will be the percentage of *dry substance* in the hay. Under the same circumstances, the higher will be the percentage of the *comparatively indurated*, and therefore *probably effete, Woody-fibre;* and the lower will be

that of the *calculated nitrogenous compounds*, of the *impure green fatty matter*, and of the *mineral matter* in the Dry substance. On the other hand, in a large proportion of the non-Graminaceous herbage, over-luxuriance, succulence, a large proportion of leaf, and unripeness, are likely to be associated with a small proportion of the *more refractory or effete Woody-fibre*, but with a large one of *nitrogenous substance in a questionable degree of elaboration*, a large one of *impure fatty matter* of doubtful nutritive capacity, and a large one of the *mineral matter* also, in the Dry substance of the hay.

This subject obviously throws open a wide field for future investigation. And, if we consider, not only the very complex character, in so many points of view, of the substance included under the term—*hay*, but also the inadequacy of the data, although so voluminous, which we have collected and recorded in the course of our long Paper, it will be at once apparent, that it would be inconsistent with a proper spirit of inquiry, to attempt to do more than draw attention to the prominent indications, and leading directions, of the experimental evidence that has been adduced. There will, nevertheless, be much really gained, if a clear idea be conveyed of the multiplicity of circumstances, upon which must depend the proportion, and relative feeding value, of the various chemical compounds of which the complex produce is made up. It will, then, be understood—and it is very important that it should be—that even supposing there were no question as to the proper relationship to one another, of the different constituents of our stock-foods, it would still be impracticable to get a true and unconditional estimate of comparative feeding value of *crude vegetable substances*, by the simple determination of the percentage amount of one or two important constituents, as is frequently assumed to be sufficient for that purpose. The next step in advance in these inquiries can only be attained, when our knowledge of the proximate compounds, of lower or of higher condition of elaboration, into which the ultimate constituents of our food-stuffs are grouped, has been much extended, and when the digestibility, and applicability to the purposes of the system, of these various proximate compounds, have been experimentally determined.

For the general conclusions in regard to the other separate Sections of the subject into which our Report has been divided, the reader is referred to the concluding portions of Parts I., II., and III. respectively, as follows: Part I.—vol. XIX., pp. 571-3; Part II.—vol. XX., pp. 245-6; and Part III.—vol. XX., p. 272, of this Journal.

APPENDIX.

APPENDIX.—TABLE I.—Duplicate Determinations of DRY MATTER (at 212° F.) in the HAY of the Seasons 1856, 1857, and 1858.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Season 1856.		Season 1857.		Season 1858.	
		Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.						
1	Unmanured	82·1	81·8	85·0	85·3	86·0	85·9
2	Unmanured (duplicate plot)	81·6	82·2	87·3	87·3	85·8	85·1
	Calculated Means of Unmanured	81·8	82·0	86·1	86·3	85·9	85·5
3	2000 lbs. Sawdust	80·6	80·8	87·9	87·5	84·2	84·6
4	200 lbs. each, Sulphate and Muriate Ammonia	79·0	81·0	87·2	86·1	84·0	84·2
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	79·8	79·5	87·7	87·6	84·0	83·8
6	275 lbs. Nitrate of Soda	..	..	..	..	84·6	85·0
7	550 lbs. Nitrate of Soda	..	..	..	..	85·7	86·0
	SERIES 2.—With Direct Mineral Manure.						
8	"Mixed Mineral Manure"*	80·5	80·0	86·8	86·7	85·6	85·6
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	80·6	80·4	86·8	86·8	84·0	84·2
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	78·9	79·0	87·1	87·0	82·0	82·2
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	77·8	76·8	87·6	86·8	83·9	83·8
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	79·4	79·0	86·5	87·1	82·4	82·4
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	77·8	78·4	86·1	85·8	80·2	81·1
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	..	..	..	..	86·1	86·7
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	..	..	..	..	85·4	85·0
	SERIES 3.—With Farmyard Manure.						
16	14 Tons Farmyard Manure	76·0	76·2	87·4	87·3	85·0	84·2
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	79·5	79·6	86·4	86·1	82·4	83·0

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE II.—Duplicate Determinations of MINERAL MATTER (Ash), in the Hay of the Season 1856.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land. Experiment 1.	Experiment 2.	Percentages in the Dry Substance of the Hay. Experiment 1.	Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	6·25	6·27	7·61	7·66
2	Unmanured (duplicate plot)	6·60	6·68	8·09	8·12
	Calculated Means of Unmanured	6·42	6·48	7·85	7·89
3	2000 lbs. Sawdust	6·60	6·64	8·19	8·21
4	200 lbs. each, Sulphate and Muriate Ammonia	6·75	6·13	8·55	7·56
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	5·95	6·06	7·47	7·62
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	6·94	6·91	8·62	8·64
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	7·39	7·23	9·18	8·99
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	6·64	6·91	8·42	8·74
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	7·23	6·83	9·29	8·90
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	6·78	6·67	8·54	8·44
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	6·74	6·40	8·66	8·16
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	7·30	7·29	9·59	9·56
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	8·66†	6·38†	10·88†	8·01†

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

† There is obviously some error in these determinations; whether due to the accidental mixture with one another of a portion of the duplicate quantities, or to adventitious matter in the case of the higher number, is doubtful. It will be easily understood that in such complex and uneven produce as hay, the determinations of both Dry matter, and Mineral matter, will be [illegible]

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE III.—Duplicate Determinations of MINERAL MATTER (Ash), in the Hay of the Season 1857.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.		Percentages in the Dry Substance of the Hay.	
		Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	5·58	5·68	6·56	6·66
2	Unmanured (duplicate plot)	5·71	5·71	6·54	6·54
	Calculated Means of Unmanured	5·65	5·69	6·55	6·60
3	2000 lbs. Sawdust	5·60	5·68	6·37	6·49
4	200 lbs. each, Sulphate and Muriate Ammonia	5·52	5·44	6·33	6·31
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	5·55	5·47	6·33	6·25
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	6·00	6·32	6·91	7·29
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	6·83	6·36	7·87	7·33
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	6·32	6·24	7·26	7·17
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	6·43	6·40	7·34	7·37
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	6·78	6·67	8·54	8·44
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	6·49	6·35	7·53	7·40
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	6·46	6·56	7·39	7·52
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	6·48	6·42	7·50	7·46

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE IV.—Duplicate Determinations of MINERAL MATTER (Ash), in the Hay of the Season 1858.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.		Percentages in the Dry Substance of the Hay.	
		Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	5·73	5·68	6·66	6·61
2	Unmanured (duplicate plot)	5·56	5·56	6·48	6·53
	Calculated Means of Unmanured	5·64	5·62	6·57	6·57
3	2000 lbs. Sawdust	5·60	5·62	6·65	6·64
4	200 lbs. each, Sulphate and Muriate Ammonia	5·39	4·88	6·42	5·80
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	5·34	5·32	6·36	6·34
6	275 lbs. Nitrate of Soda	5·80	5·66	6·85	6·66
7	550 lbs. Nitrate of Soda	5·37	5·39	6·26	6·27
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	6·48	6·48	7·57	7·57
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	6·48	6·46	7·71	7·68
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	6·53	6·54	7·96	7·95
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	6·96	6·64	8·30	7·92
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	6·69	6·67	8·12	8·10
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	6·32	6·38	7·88	7·86
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	6·37	6·43	7·39	7·42
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	6·38	6·66	7·47	7·83
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	6·73	6·71	7·92	7·97
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	6·72	6·75	8·15	8·13

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE V.—Duplicate Determinations of NITROGEN, in the Hay of the Season 1856.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.		Percentages in the Dry Substance of the Hay.	
		Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	1·70	1·66	2·07	2·03
2	Unmanured (duplicate plot)	1·79	1·79	2·19	2·18
	Calculated Means of Unmanured	1·74	1·72	2·13	2·10
3	2000 lbs. Sawdust	1·69	1·66	2·09	2·06
4	200 lbs. each, Sulphate and Muriate Ammonia	1·57	1·57	1·96	1·96
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·56	1·62	1·96	2·03
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure" *	1·67	1·68	2·08	2·10
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	1·80	1·75	2·24	2·18
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	1·22	1·24	1·54	1·57
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·28	1·25	1·66	1·62
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	1·48	1·46	1·86	1·85
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	1·49	1·49	1·88	1·88
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	1·35	1·35	1·77	1·78
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	1·65	1·60	2·07	2·01

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

Experiments with Different Manures on Permanent Meadow Land.

APPENDIX.—Table VI.—Duplicate Determinations of Nitrogen, in the Hay of the Season 1857.

Plot, Nos.	MANURES, (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.		Percentages in the Dry Substance of the Hay.	
		Experiment 1.	Experiment 2.	Experiment 1.	Experiment 2.
	Series 1.—Without Direct Mineral Manure.				
1	Unmanured	1·29	1·29	1·52	1·52
2	Unmanured (duplicate plot)	1·42	1·45	1·63	1·66
	Calculated Means of Unmanured	1·35	1·37	1·57	1·59
3	2000 lbs. Sawdust	1·38	1·38	1·57	1·57
4	200 lbs. each, Sulphate and Muriate Ammonia	1·59	1·51	1·83	1·74
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·54	1·45	1·76	1·66
	Series 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	1·51	1·51	1·74	1·74
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	1·49	1·48	1·72	1·71
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia ..	1·19	1·18	1·37	1·36
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·12	1·10	1·29	1·26
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	1·38	1·29	1·60	1·51
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia ..	1·62	1·62	1·89	1·88
	Series 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	1·29	1·33	1·48	1·52
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia ..	1·07	1·10	1·24	1·28

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE VII.—Duplicate Determinations of NITROGEN, in the Hay of the Season 1858.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land. Experiment 1.	Percentages in the Hay as taken from the Land. Experiment 2.	Percentages in the Dry Substance of the Hay. Experiment 1.	Percentages in the Dry Substance of the Hay. Experiment 2.
	SERIES 1.—Without Direct Mineral Manure.				
1	Unmanured	1·39	1·42	1·62	1·65
2	Unmanured (duplicate plot)	1·35	1·34	1·58	1·57
	Calculated Means of Unmanured	1·37	1·38	1·60	1·61
3	2000 lbs. Sawdust	1·41	1·42	1·67	1·68
4	200 lbs. each, Sulphate and Muriate Ammonia	1·69	1·61	2·01	1·92
5	200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·56	1·56	1·86	1·86
6	275 lbs. Nitrate of Soda	1·67	1·69	1·97	1·99
7	550 lbs. Nitrate of Soda	1·71	1·71	1·99	1·99
	SERIES 2.—With Direct Mineral Manure.				
8	"Mixed Mineral Manure"*	1·39	1·42	1·63	1·66
9	"Mixed Mineral Manure," and 2000 lbs. Sawdust	1·39	1·39	1·65	1·65
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia ..	1·25	1·26	1·52	1·53
11	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Sawdust	1·18	1·17	1·41	1·40
12	"Mixed Mineral Manure," 200 lbs. each, Sulphate and Muriate Ammonia, and 2000 lbs. Cut Wheat-Straw	1·34	1·36	1·63	1·65
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia ..	1·70	1·72	2·11	2·13
14	"Mixed Mineral Manure," and 275 lbs. Nitrate of Soda	1·52	1·52	1·76	1·76
15	"Mixed Mineral Manure," and 550 lbs. Nitrate of Soda	1·31	1·34	1·54	1·57
	SERIES 3.—With Farmyard Manure.				
16	14 Tons Farmyard Manure	1·18	1·18	1·40	1·40
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia ..	1·29	1·25	1·56	1·51

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 556, of this Journal.

Experiments with Different Manures on Permanent Meadow Land.

APPENDIX.—Table VIII.—Duplicate Determinations of Woody Fibre, in the Hay from Selected Plots; Seasons 1856, 1857, and 1858.

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Percentages in the Hay as taken from the Land.			Percentages in the Dry Substance of the Hay.		
		Experiment 1.	Experiment 2.	Experiment 3.	Experiment 1.	Experiment 2.	Experiment 3.
	Season 1856.						
1	Unmanured	24·76	24·27	..	30·2	29·6	..
4	200 lbs. each, Sulphate and Muriate Ammonia	24·96	24·72	..	31·2	30·9	..
8	"Mixed Mineral Manure" *	23·98	24·14	..	29·9	30·1	..
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	25·52	25·52	..	32·3	32·3	..
13	"Mixed Mineral Manure," and 400 lbs. each Sulphate and Muriate Ammonia	25·85	25·38	..	33·1	32·5	..
16	14 Tons Farmyard Manure	24·12	23·44	..	31·7	30·8	..
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	23·56	23·72	..	29·6	29·8	..
	Season 1857.						
1	Unmanured	23·32	23·15	22·11	27·4	27·2	26·1
4	200 lbs. each, Sulphate and Muriate Ammonia	22·89	23·41	22·89	26·4	27·0	26·4
8	"Mixed Mineral Manure"	23·06	23·06	22·89	26·6	26·6	26·4
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	25·40	24·97	25·40	29·2	28·7	29·2
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	24·14	24·57	23·79	28·1	28·6	27·7
16	14 Tons Farmyard Manure	26·19	26·19	25·14	30·0	30·0	28·8
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	24·57	24·91	25·43	28·5	28·9	29·5
	Season 1858.						
1	Unmanured	22·68	22·68	23·28	26·4	26·4	27·1
4	200 lbs. each, Sulphate and Muriate Ammonia	22·54	22·96	23·13	26·8	27·3	27·5
8	"Mixed Mineral Manure"	25·08	24·65	25·17	29·3	28·8	29·4
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	24·05	24·55	23·73	29·3	29·9	28·9
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	23·24	23·32	24·37	28·8	28·9	30·2
16	14 Tons Farmyard Manure	24·19	24·11	25·21	28·6	28·5	29·8
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	24·15	24·15	24·64	29·2	29·2	29·8

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix. p. 558, of this Journal.

EXPERIMENTS with DIFFERENT MANURES on PERMANENT MEADOW LAND.

APPENDIX.—TABLE IX.—Duplicate Determinations of FATTY MATTER (by Ether), in the Hay from Selected Plots (Season 1858).

Plot, Nos.	MANURES. (Per Acre, per Annum.)	Experiment 1.	Experiment 2.	Mean.
	Percentages in the Hay as taken from the Land.			
1	Unmanured	2·87	2·86	2·86
4	200 lbs. each, Sulphate and Muriate Ammonia	3·04	2·96	3·00
8	"Mixed Mineral Manure" *	2·58	2·52	2·55
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	2·04	1·93	1·99
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	2·43	2·29	2·36
16	14 Tons Farmyard Manure	2·49	2·46	2·47
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	2·81	2·79	2·80
	Percentages in the Dry Substance of the Hay.			
1	Unmanured	3·34	3·33	3·34
4	200 lbs. each, Sulphate and Muriate Ammonia	3·61	3·52	3·57
8	"Mixed Mineral Manure"	3·01	2·94	2·98
10	"Mixed Mineral Manure," and 200 lbs. each, Sulphate and Muriate Ammonia	2·49	2·35	2·42
13	"Mixed Mineral Manure," and 400 lbs. each, Sulphate and Muriate Ammonia	3·01	2·84	2·93
16	14 Tons Farmyard Manure	2·94	2·91	2·93
17	14 Tons Farmyard Manure, and 100 lbs. each, Sulphate and Muriate Ammonia	3·40	3·38	3·39

* For full description of the "Mixed Mineral Manure," see Part I. of this Paper, vol. xix., p. 55C, of this Journal.

XXIII.—*Agricultural Maxima.* By JOHN C. MORTON.

INSTANCES of extraordinary produce will occur to most men on reviewing ten or twelve years of agricultural experience. It must be confessed, indeed, that they have scarcely affected the average profits of farming, and that they have hardly at all influenced the quantity of food yielded per acre within their neighbourhoods during the year of their occurrence. A general increase of profit and productiveness, by creating employment for more labourers, would raise wages, and, as indicating an increased value of land, would necessarily raise rents; but no such results of any general progress can be remembered in connection with the maximum instances of any man's agricultural experience. They have been entirely exceptional occurrences, almost without effect on the interests of landlord, labourer, or tenant. Add to this that they have been generally owing to the concurrence of extraordinary natural circumstances acting on good ordinary farming rather than to any special effort on the part of the cultivator—that, in fact, they have *happened* rather than been *sought*—and we might suppose that these agricultural maxima were of little or no agricultural interest. But this would be a very hasty conclusion. Notwithstanding that they generally come unsought, it is by an examination of the circumstances out of which they have arisen that we are most likely to find out the causes of our ordinary as well as of our extraordinary successes; and notwithstanding that these particular instances seem of little lasting service, yet it is plainly on the multiplication of them that our expectations of increasing agricultural progress are most reasonably built. It seems obvious from the history of this progress hitherto that our annual produce of food is more likely to increase by the general achievement of our remarkable successes, than by the establishment or adoption of altogether novel doctrine or novel practice. And although most of our agricultural maxima have been owing to the concurrence of natural advantages independently of the labour of the cultivator, yet no one can examine the agriculture of any considerable district without discovering that its most notable instances are the artificial result of enterprise and skill. Plainly, it is the good cultivator only who gives full scope to the natural influences when they happen to be especially favourable. On the ground, then, both of the probability of their usefulness, and of the obvious possibility of gaining practical instruction from them, the circumstances of our agricultural maxima deserve examination; and good service will be done by any reader of this paper, able to recall instances of the kind, who shall communicate the full history of them to the Journal of the Royal Agricultural Society.

The following cases, given as a preliminary illustration of the kind of information desired, are necessarily a mere collection of particulars, each complete in itself, but without relation to its neighbour. When a larger number of instances shall have been collected, it may be possible, by arranging them according to such circumstances as they possess in common with each other, to read some general truth in their details; for the present, however, no arrangement of them has been attempted. Our object has been simply to place on record a number of well-authenticated occurrences of the kind, whether explained or not by such history as is given of them.

1. Mr. H. S. Thompson, M.P., of Kirby Hall, York, informs me that, in December, 1856, he sold a fat steer of the short-horn breed, which had been calved in January, 1855, and was therefore just over 22 months old when killed. It weighed then 69 stones 10 lbs. (imp.). The cow, having been crippled by rheumatism, was allowed to suckle her calf at grass until it was 6 or 7 months old, with the hope of bringing her round. The calf, when about 6 months old, had a fall, and either broke its shoulder or so damaged it as to be exceedingly lame from that time forwards. It was fed when in the fatting-house on cut food, turnips, hay, and cake, and sold for 29*l.* at 22 months old. How far this is beyond ordinary and even extraordinary experience, may be gathered from the following instances sent to me as maxima from the north of Scotland :—Mr. John Collie, of Ardgay, Elgin, has two yearling cattle of the polled Aberdeenshire breed, 17 and 18 months old respectively, which girth 6 ft. 9 in., and are 4 ft. 6 and 4 ft. 3 in. long respectively—averaging, therefore, according to the usual formula, and supposing them "moderately fat," 48 stones (imp.) each. Mr. John Hunter, of Dipple, Fochaber, has a 20 months'-old cross-bred bullock, between short-horn bull and polled cow, girthing 7 feet, and weighing, according to measurement, 54 stones (imp.). Little instruction can be gained by comparing animals of different breeds, unless information be also given of the food they have respectively consumed; but the Aberdeenshire breed is not inferior to the short-horn in the size of the full-grown animal, and these instances do therefore serve to mark out the case of Mr. Thompson's steer as an agricultural maximum.* That gentleman writes me as follows:—

* Since this paper has been in type, Mr. Richard Shirley, of Bawcott, Munslow, Shrewsbury, has sent me the following particulars of his fat Hereford steer which carried off the Gold Medals at the last Show (Dec. 1859) of the Smithfield Club and of the Midland Counties Association. His age when slaughtered was 2 years 6 months and 27 days; and his carcase weight was 87 stones 6 lbs. (imp.) It sucked its dam until 5 months old, and, being then weaned, was put with others in a yard; receiving cut swedes, straw, and hay until one year old. It was then

"The two points of most interest in this case are—1st, That, though killed at one year and ten months old, the beef was of first-rate quality; and, 2nd, that the proportion of offal was unusually small. I had on several previous occasions found that animals well fed from the time of their birth weighed more in proportion to their measurement than those which had been kept in store condition for a year or two before being fattened, and the above-mentioned steer furnishes so striking an illustration of the fact, as to deserve more particular mention. The early maturity of this ox had excited some interest in the neighbourhood of my farm, and I requested four or five good judges of cattle to give me their opinion as to his weight. I also had him measured and weighed. The estimates of his dead weight, grounded upon his *appearance* and *handling*, on his *measurement* and on his *live weight*, did not vary materially from one another, and the highest estimate did not exceed 64 stone (imperial). He was sold for Christmas beef at 9*s.* per stone on his estimated weight, and realized 29*l.* As he was bought by a neighbouring butcher, my bailiff had the opportunity of seeing him after he was slaughtered, when he was found to weigh nearly six stone more than was expected. I have never found the estimates of good judges of fat cattle, especially when fortified by the measuring-tape and the weighing-machine, to be far wrong, except in cases like this—of liberal feeding from the time of birth and early slaughtering. In all such instances where I have had the opportunity of verifying the dead weights, the animal has weighed some stones more than had been anticipated. I am satisfied that, as a rule, we do not commence feeding our cattle sufficiently early. By fattening them young, we turn over our capital quicker; they are fattened at less expense, because they eat less; and we learn from this and similar cases that the beef is as good, whilst the offal is less than in beasts of greater age."

2. The following are well-authenticated instances from the neighbourhood of Long Sutton, Lincolnshire, given to me by Mr. J. Algernon Clarke. (*a*) In 1846 Mr. Jóhn Clarke fed a long-woolled ewe to the weight of $65\frac{1}{2}$ lbs. a quarter. (*b*) The same gentleman had a long-woolled ram which clipped $51\frac{3}{4}$ lbs. of wool in 3 years, averaging therefore $17\frac{1}{4}$ lbs. a fleece. (*c*) Mr. John Bush, farmer, Long Sutton, in 1859, grew 92 bushels of mangold-seed on 3 roods of land, equal to 120 bushels per acre. These are to be taken merely as instances of the yield possible in the several cases. No history has been sent in connection with them.

3. The following is a case of a somewhat similar kind given to me by Mr. E. Evans, of Boveney Court, near Windsor, who at the time of its occurrence resided near Wigan, Lancashire. In 1842 Mr. Charles Holmes, of Orrell Hall, near Wigan, grew $435\frac{1}{2}$ bushels of beans (60 lbs. per bushel) and 12 tons $6\frac{1}{2}$ cwt. of straw on 5A. 0R. 13P. of land, being $85\frac{2}{3}$ bushels of beans and $48\frac{1}{2}$ cwt. of straw per acre.

4. Mr. Blundell, of Bursledon, Southampton, an active mem-

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turned out with other calves and feeding cows until the following October; when it was taken in and received as much cake, meal, cut swedes, and hay as it would eat, along with a portion of Simpson's Food daily for the last six months. It was not turned out again from October 1858; being in altogether about 14 months.

ber of the Botley Farmers' Club, and frequently a judge at the annual meetings of the Royal Agricultural Society, informs me that, in 1857, on a field of light loamy soil in his occupation, he grew an extraordinary crop of the white Belgian carrot, of which the following particulars give the history.

"Fallow preparation: *soil*, sandy loam; *seed*, white Belgian carrot, 6 lbs. per acre, drilled May 14th, 16 inches apart between the rows; *manure*, 2 cwts. superphosphate of lime and 25 bushels of ashes per acre; the crop flat-hoed between the rows; the rows thinned by hand-pulling, which afforded 14 tons per acre of excellent food for cattle from 1st August to 14th September. The roots we raised in the second week of November weighed 24 tons 18 cwts. 2 qrs. per acre, there being 348 roots per pole; the tops weighed by estimate 7 tons 5 cwts. per acre; total weight of crop per acre, 46 tons 3 cwts. 2 qrs. On a part of the same field, the crop, not thinned in the rows, raised at the same time, weighed 31 tons 2 cwts. 3 qrs. per acre, there being 980 plants per pole, the tops weighing by estimate 6 tons 10 cwts. per acre; total weight of crop per acre, 37 tons 12 cwts. 3 qrs."

In 1858 the following was Mr. Blundell's experience of the same crop:—

"*Preparation.*—One ploughing after a good crop of trifolium cut for soiling cattle; manured with yard-dung, 25 tons per acre, before ploughing. We drilled with the seed 8 bushels of bone-dust and 20 bushels of ashes per acre: 6 lbs. of white Belgian carrot-seed per acre were drilled May 22nd, 16 inches apart between the rows; the crop was flat-hoed between the rows; the rows thinned by hand-pulling, which afforded 12 tons per acre of cattle-food from August 2nd to September 16th; the roots, raised second week in November, weighed 19 tons 4 cwts. 32 lbs., there being 395 roots per pole, the tops estimated to weigh 7½ tons per acre; total weight of crop per acre, 38 tons 14 cwts. 32 lbs."

With reference to these figures Mr. Blundell says that neither the thinnings of the crop nor the greens were weighed, but that, having often weighed the greens from his carrot-crop up to 9 tons per acre, he is confident in the accuracy of his estimate. The main crop of roots was actually weighed.

5. The following still more remarkable history has probably never been paralleled, and may therefore be recorded as a genuine agricultural maximum. It relates to a period of fifteen years ago, but is authenticated by trustworthy eye-witnesses. Mr. William Cubitt, of Bacton Abbey, North Walsham, well known in Norfolk as an energetic practical agriculturist, writes as follows:—

"I now send you a short history of the extraordinary field of wheat to which I previously alluded, as also a communication on the subject from the owner and occupier of the land, George Wilkinson, Esq., whose veracity may be relied on.

"This field, situated in the parish of Haisborough, about four furlongs from the sea, contains 5A. 1R. 38P., and is of average fertility with the lands adjoining, being a good loamy soil resting upon a strong subsoil, but sufficiently porous not to require draining, and suitable to every kind of cropping.

"In 1843 it was sown with peas, probably preceded by wheat. In the autumn of that year it was again sown with 'Spalding' wheat—about 3

bushels of seed per acre. It came up thickly, and in the following spring and during the summer it presented an unusually luxuriant appearance, particularly when fully shot into ear, so much so as to attract the attention of all passers by. Many bets were made by practical men as to its probable yield, some estimating the produce at 9 quarters per acre. The field was harvested separately, and on threshing yielded 11 quarters 2 bushels per acre. In the same season and upon land almost adjoining, but occupied by another, 10 quarters per acre were produced. In the parish from which I write, the same harvest produced upon land near the sea from 7½ to 9 quarters of wheat per acre, and an equal yield of barley. These are the largest crops on record in this neighbourhood—5 quarters of wheat per acre, and from 5 to 6 quarters of barley, being a *full average*. These heavy crops to which I have alluded cannot be *in any degree* owing to high or extra farming, for, although 1844 is of such recent date, yet at that period it was not the custom upon the good lands of this district, as now, to use artificial manure for roots, nor to consume them with so great an admixture of oil-cake and other artificial food as during the last few years; and yet, for all this, the produce does not perceptibly increase; on the contrary, with regard to the inferior grain, especially barley, it has become a general complaint through this part of the county that it has of late years deteriorated both in quantity and quality; therefore I cannot but arrive at the conclusion that extra prolific crops are *not so much the necessary consequences of high farming* as of *favourable seasons*. Now, 1844 being the most prolific year ever known in this neighbourhood, the question arises, What were the peculiarities of that season? I am only in a position to assert that the summer of that year was the most genial I ever remember; the drought was not equal to the two just past, but from the month of March till the end of September we had an unusual number of sunny days, with fewer storms and atmospheric changes."

. . . . "Since writing the above I have been informed by Mr. Wilkinson that the field in question had not been treated differently from other parts of the farm. The usual 4-course system was pursued; but to lessen the acreage of the root-crop it is often the custom on such lands to take a crop of peas or beans after wheat, and then wheat again, as was the case in the instance referred to. With regard to the other crop of 10 quarters per acre, it was grown by a gentleman (Mr. Howes) who had occupied land in the parish for a period of fifty years, and who had been frequently heard to affirm that he never before grew anything approaching to such a crop; 7 quarters per acre being the largest crop his land ever produced previously to 1844.

"It may also be interesting to state that Mr. Wilkinson again planted wheat on the field producing this very extraordinary crop the succeeding year, and the yield was something less than 4 quarters per acre. He farms 400 acres, and the land is all of the finest quality. His statistics, given below, refer to the coomb of 4 imperial bushels.

"The land I occupy is very similar, and I have come to the conclusion that to farm it unusually high, and stick to the usual 4-course system, is occasionally attended with great loss and disappointment. My plan of late years has been to pursue *no particular course*, but to crop close and extend the rotation, as, for instance, thus:—1, turnips or mangold-wurzel; 2, wheat or oats; 3, barley; 4, clover, or other seeds, or beans; 5, wheat; which is a kind of 5-course shift, care being taken not to lay down more land with seeds than is required for the use of my horses. After barley, therefore, I usually grow a field or two of beans, but always grow as large a shift of roots as possible, being generally *well paid* by the winter grazing of sheep and cattle, and also by the means thus afforded of getting the straw made into good manure."

Mr. Wilkinson, the owner of the field in question, writes thus to Mr. Cubitt:—

"N. Walsham, 25th Nov. 1859.

"DEAR SIR,—I am unable to find the particulars of the crop grown in 1844 in the stable-close containing 5A. 1R. 38P. The produce exceeded 22 coombs an acre, landlord's measure; and I think it amounted to 22 coombs 2 bushels. The previous crop was peas.

"I attribute this abundant crop to the season, and not to any particular course of husbandry.

"I send you my average for seven years, including 1844, both of wheat and barley, and am

"Yours truly,
"GEORGE WILKINSON.

	Wheat.				Barley.		
	C.	B.	P.		C.	B.	P.
"Harvest 1844	13	0	2	....	13	0	0
" 1845	8	3	0	....	11	3	0
" 1846	10	3	0	....	10	1	0
" 1847	10	0	2	....	12	0	0
" 1848	9	1	2	....	10	0	0
" 1849	11	2	0	....	11	2	0
" 1850	9	2	3	....	9	3	1
	7)73	1	1		7)78	1	1
Average produce per acre for the last 7 years	10	1	3		11	0	3
	or 5 qrs. 1 bush. 3 pecks.				5½ qrs. 3 pecks."		

6. Mr. John Wilson, of Edington Mains, Berwickshire, author of the article 'Agriculture' in the 'Encyclopædia Britannica,' and well known in the North as a most intelligent agriculturist, gives me the following instances of agricultural maxima within his knowledge or experience:—

"(*a*). In 1824 a field on this farm of 40 acres produced a crop of potato-oats of excellent quality, which yielded 84 bushels per acre over the whole field.

"(*b*). Some years earlier—I cannot give the year—a field of 11 acres adjoining the foregoing bore a crop of the common Scotch bean, which yielded 600 bushels.

"(*c*). During the past thirty years I have on three different occasions had 60 bushels of barley per acre over an entire field. The first instance was on a 20-acre field, and the common long-eared barley. The two others were on a 33-acre field—first with Norfolk barley, and second with Annat. The Norfolk barley weighed 57½ lbs. per bushel. In all these barley crops the proportion of tail-corn was quite insignificant—about 1½ per cent. only.

"(*d*). In 1826—a season of unusual drought and heat, and the earliest harvest in the current century—the wheat crop (Hunter's variety) on a farm in this district, extending to nearly 60 acres, averaged 48 bushels per acre of marketable grain over the whole breadth, the grain being of unusually fine quality.

"(*e*). In the same year, on another farm in the same neighbourhood, two fields of considerable size—one in red wheat, the other white—were said to have yielded 60 bushels per imperial acre.

"(*f*). More recently, although I cannot state the year, 5 acres were measured off in a field of wheat (Hunter's variety) on a farm in this district; and these 5 acres lying contiguous, but selected as being apparently the best portion of the field, were found to yield 66 bushels per acre—the highest yield that has come to my knowledge.

"(*g*). In the year 1829 I was informed by the late Mr. George Clarke, then occupier of the farm of Barnby Moor, Notts, that two or three years before he had a field of Hunter's wheat which yielded 60 bushels per acre.

"(*h*). Early in the current century a field close to a neighbouring village, which had been long in grass, produced a crop of oats which yielded at the rate of 94 bushels per acre over a field of at least 30 acres. The exact year or variety of oats I cannot tell, but I had the information from the brother and successor of the person who then occupied the farm.

"With the exception of the fifth instance, all these examples of large produce I know either by personal experience or by information at first-hand from trustworthy persons. I have given *you* the names of farms and farmers to give point and definiteness to the cases, but, if published, their names must be suppressed, as I am not at liberty to publish what was told me in confidence by others. I should add that the first five instances refer to crops grown on strong loams belonging to the lower carboniferous formation; (*f*) and (*h*) are on lighter loams on the old red sandstone. It is also worthy of note that the most abundant crops of wheat of which I am aware were of Hunter's variety.

"I know how much is wanting in all these cases to render them really valuable, but I send them, such as they are."

7. Some of these instances, though maxima in the district of their occurrence, have been exceeded elsewhere. The crops of oats, for instance, have been not unfrequently largely exceeded. On Whitfield Farm, near Thornbury, Gloucestershire, on a field named Ferney Hurst, about 11 acres in extent, a sandy loam on the old red sandstone formation, which had been broken up out of old pasture by paring and burning, and had then borne a crop of turnips partly fed off with sheep, a crop of white Tartarian oats was reaped, which exceeded 13½ quarters per acre. I have no record of the year, but the field was noteworthy in the second year after this crop of oats for the remarkable deficiency of two lands in the midst of a very good crop of wheat, which had been left unlimed when the field received a liberal dressing on the oat stubble. These "lands" were the more observable owing to the seed-furrow for the wheat having been across the former ploughing, so that they stretched 5½ yards wide a-piece obliquely across the ridges in which the wheat had been sown, exhibiting in comparatively stunted and scanty straw a most striking contrast to the general character of the crop, and a most instructive lesson on the value of lime as a dressing for newly-broken-up sandy soil.

8. Mr. Smith, of Woolstone, near Bletchley Station, Buckinghamshire, communicates the following history of a mangold-wurzel crop raised this year:—

"In October, 1858, I spread in the ordinary way 10 tons of farmyard manure per acre over the wheat stubble, the manure having been taken from the yard and stacked in May. I then trench-ploughed to a depth of 9 inches by steam-power, at a cost, including wear and tear, of 10*s*. 2*d*. per acre; I then subsoiled between the ridges with horses to the depth of 14 inches, at a cost of 3*s*. per acre; in this state it lay through the winter until the middle of April, when I sent two men with hand-hoes to clear the annuals from the tops of the ridges, and a hand-drill to drill the mangold-seed with. The two

men did the whole of the hoeing and drilling of the 7 acres in 3 days. They were kept clean by horse and hand-hoeing. The rows were 36 inches from row to row, and the plants in the rows averaged 24 inches from plant to plant. The average weight on the 7 acres was 17 lb. per root. The weight per acre was 55 tons 2 cwt.

"My land is now ready in the same way for the next year's crop, which will be the fourth year upon the plan."

9. The following is the full history of another remarkable crop of mangolds, grown on Wroxton Abbey Farm, near Banbury, the property of Colonel North, M.P., and given to me at his desire by Mr. James Innes, Colonel North's agent:—

"The land on which this crop was grown is a deep loam, and when taken in hand was a poor unproductive piece of pasture, full of rushes, &c., and very wet from want of proper underground drainage. It was first (in 1854) thoroughly drained 4 feet deep; and as it produced but little herbage, the grasses being chiefly subaquatics, I determined to bring it into tillage for a few years previous to laying it down again.

"In the beginning of 1856 the surface was breast-ploughed and burnt, at a cost of 4*l.* 10*s.* per acre; half the ashes were carted off to be used with artificial manure on other land intended for Swedes, and the remaining portion evenly spread over the field. The field was then ploughed to the depth of about 14 inches by one plough following another in the same furrow, each plough going as deep as possible. I may mention that I consider paring and burning to be the best system of breaking up old pasture of this description, as by it all surface weeds, &c., are effectually destroyed, and the ashes make a good manure.

"In April (1856) the field was sown with oats, excepting a small portion which could not be prepared in time, and was therefore sown with common turnips.

"In the following December I had some winter beans sown on that part that had previously been oats, and oats where the turnips had grown. The beans were drilled in rows 28 inches apart, and after they had been well horse-hoed three times, white Pomeranian turnips were sown betwixt the rows, to be consumed on the land by sheep after the beans were drawn off.

"The portion that had been oats in 1857 was, in the following October, sown with Lammas wheat; but, owing to the plant not having a firm root-hold, the corn was much laid, and the produce of a very thin and ordinary description. Spring wheat was sown on the piece that had been beans and turnips, but the yield was like the other, light and inferior.

"With a view to remove the excess of organic matter usually found in newly-broken-up land, and also to hasten the decomposition of the vegetable remains, and thus furnish a supply of feeding material for the use of plants, I had a good dressing of lime (about 100 bushels per acre) spread over the land in the autumn, and immediately ploughed in; this ploughing being done, as in the first case, to the depth of 14 inches, by two ploughs, one following in the furrow of the other.

"In the beginning of April this year the land was thrown into ridges, about 27 inches apart, by a double mould-board plough; well-rotted farm-yard dung was then spread in between these ridges at the rate of 15 cart-loads per acre. The ridges were then turned back or "split" so as to cover the manure (care being taken not to have more ridges manured than could be split in the same day). Before, however, this was done, I had the following artificials (after they had been finely pulverised by a small machine made for that purpose, and so rendered more available for the use of the plants) sown by hand on the top of the dung:—2 cwt. guano, 2 cwt. Proctor and Ryland's mangold manure, 2 cwt. salt, per acre, on part of the field; and 3 cwt. Proctor

and Ryland's mangold manure, 3 cwt. salt, on a small piece sown with long mangolds. On one part of the field I put, for experiment, some superphosphate in lieu of the 2 cwt. of Proctor and Ryland's manure, mentioned in the first case; but the quantity applied was of the same money value. These experiments, however, were not taken into account when selecting the average of the field. I ought to mention that previous to the land being ridged I applied about 2 cwt. salt per acre over the whole of it. After the ridges had been turned back or "split" and rolled down, the seed was drilled; the quantity sown being 6 lbs. per acre. As soon as the rows were visible, the horse-hoe (a single-horse one) was drawn down the intervals, and when the plants were from 3 to 4 inches high they were side-hoed and singled out to a distance of 16 inches apart, the strongest plants being left where possible and the blanks filled up by transplanting. This was performed with a small garden-trowel, in order that the roots of the plants should not be injured nor turned up in planting, as is too often the case. In a few weeks the transplanted ones could not be distinguished from the others. The crop was afterwards horse-hoed as *often and deep as could be done without injuring the plants*, and to this and deep autumn tillage I attribute in a great measure my great success.—On the 25th October the judges of the Banbury Agricultural Association weighed a square rod, and found the average weight of the field to be 63½ tons per acre. On the 15th November Mr. Ryland, of Birmingham, and other gentlemen, having expressed a wish to see the crop, selected what they considered a fair average piece (1-16th of an acre), and found the weight to be 64 tons 1 cwt. 1 qr. 20 lbs. per acre."

10. Mr. Simpson, of Teawig, near Beauly, Invernessshire, gives the following particulars of an extraordinary crop of potatoes:—

"The land on which they grew was under oats in 1858, after grass in 1857, and was stirred in the autumn of 1858 about 14 inches deep (a plough turning a deep furrow, and a subsoil plough following). It was simply grubbed across in spring 1859; then drilled (ribbed) at 30 inches with a double mould plough. 25 loads of well-made farmyard manure were spread in the drills in the latter end of April, and cut sets of potatoes *dusted with gypsum* were planted at 12 inches' distance. The sort is the *Protestant*—a kind sent to me by a friend in the west of Ireland in 1854, and since cultivated by me with invariable success. They are somewhat similar in appearance, but much superior in quality, to the kind known in London as the 'Irish White Rock.'

"I had apportioned 4 acres to the growth of different varieties for change of seed, the soil of these 4 acres being different from the rest of my farm. The acre appropriated to the Protestants was the worst piece of the four. The next piece to it was under *Flukes*, which produced but 9½ tons per acre, though put down with the same manure and 2 cwts. Peruvian guano in addition.

"The exact measurement under *Protestants* was 4704 square yards. The quantity of potatoes carted off was 29 loads, which weighed (by trial) 10 to 10½ cwts. net each. There was no disease in any of the varieties.

"I annex a sketch of the piece of ground. It may interest you to know that the line intersecting it was up till the early part of this century the great and only road from Inverness to the northern counties. It was trenched up and cropped for the first time by me in 1854." *

11. Mr. Grey, of Dilston, refers thus in general terms to autumn cultivation, as resulting in a maximum crop of

* The plan accompanying this communication represents a rectangular field divided into four nearly equal and parallel rectangular plots, with an oblique intersecting line which cuts off a corner of the field and includes about half of the plot under "Protestants,"—the soil on one side of this line is clay, on the other a black mould or gravel.

potatoes: he also gives a remarkable instance of productive pasturage:—

"(*a.*) I think I might have shown results in favour of planting potatoes upon land worked up and manured in the autumn, by the very great produce which has been reported to me, and is apparent in the bulk; but, having been from home at the time of their being taken up, it did not occur to my mind to weigh a row or two, by which the weight per acre could have been ascertained. The foreman tells me that he weighed 10 potatoes, which were 13½ lbs.; other 10, which were 14 lbs.; and 2 singly, which weighed 2 lbs. each. The produce is doubtless very great. In former years I have worked the land into drills, manured it, and planted potatoes at this season (November), and with good success; but on one occasion, when a severe frost came on, without snow, late in the season, the potatoes suffered a little, and the crop was rather deficient. Since that time I have worked and manured the land at this season, as was done with that from which the large produce I have mentioned has just been taken, and as has been done now for the next year's crop. In February or March, or as soon as the land is in good order, the plants are put in by a man stepping backward on the drill, and inserting a spade at proper intervals so deep as to reach the manure; he is accompanied by a boy or girl, who drops in the set, and the earth is allowed to close over it. In this way the land has been mellowed by the exposure to winter weather, retains its moisture much better than when newly worked up in spring, and has imbibed a richness from the gradual fermentation of the manure under the surface for some months. I have found, in the late dry summer, my small plot of 3 acres of mangold to succeed much better on land prepared in that way than that of my neighbours sown upon land worked up in the spring.

"(*b.*) There is a subject which I think particularly worthy of attention at this time, when butcher's meat and wool are by so much the most remunerative of all the farmer's produce. I am opposed to the breaking up of rich old grazing pastures, for the reason just stated; but there is much grass-land in the country of inferior quality and produce, which would pay well for reclaiming, whether to be continued in tillage or restored to pasture. My son, at Milfield Hill, in this county, had 100 acres of that description at the extremity of his estate, lying rather high, which had not been deemed worth cultivating, and was estimated at 5*s.* an acre per annum for grazing young stock. He broke it up, submitted it to a course of cultivation, and, after liming and growing some crops of oats and rape (the latter, of course, consumed on the ground by sheep to consolidate and manure it), he sowed it to grass without corn. Those fields have been let to be grazed from the 1st May to Christmas, at rents varying according to quality, from 40*s.* to 60*s.* an acre. How long this may continue one cannot say; but, at all events, after carrying so much stock, they will be in a good state for growing crops under a course of tillage."

The full history of the land to which Mr. Grey refers is given in the article Agriculture, 'Encycl. Britannica.'

12. Mention must here be made of the extraordinary growth of Italian rye-grass obtained from poor sandy soil in the neighbourhood of Ayr by the practice of irrigation, or rather by washing heavy dressings of manure into the land by copious floodings of water delivered through underground pipes. I refer especially to Mr. Telfer's experience on Canning Park Farm. The seed is sown in autumn, about 4 bushels per acre, and brushed in and watered, and left till spring. 10 or 12 tons per acre are yielded

by a first cutting in June, and immedietely after it 3 or 4 cwts. per acre of mixed Peruvian guano and sulphate of ammonia are sown upon it, and washed in by 100 tons of water per acre, poured upon it through the pipes, which water contains, moreover, such a share of the excrements of a byre of 48 cows as belongs to the period since the last pumping. In five weeks the land is again covered 3 feet high with a luxuriant growth of Italian rye-grass, weighing at least 16 to 20 tons per acre. This is cut and followed by another manuring in a similar manner, and a third cut of 16 to 18 tons may be expected pretty early in September; and a further manuring results in 10 or 12 tons per acre more towards the end of October. In spring another dressing of the water gives a cutting towards May, and a second and third cutting will be had, weighing 40 to 50 tons per imperial acre by the end of August. During the two years the land will have yielded between 80 and 100 tons of green food per acre in seven cuttings by the use of 1 ton of guano and sulphate of ammonia and nitrate of soda washed in with 700 tons of water. Whether Canning Park still presents the same remarkable fact I do not know; but the above are the particulars communicated to me five years ago by Mr. Telfer, when I walked over it.

13. No list of English agricultural maxima is complete which omits the experience of the Rev. S. Smith, of Lois Weedon, Northamptonshire. His land in one field is a clay loam, and in another a clayed gravelly soil—it has borne successive wheat crops, in the one case for 13 years, and in the other for 8 years. The crop in the former case has averaged upwards of 35 bushels per acre, and has gradually increased, so that latterly it has been more nearly 5 quarters. What especially distinguishes this from ordinary agricultural experience is that these crops are obtained without the addition of manure. The Lois Weedon mode of growing wheat consists simply in the deep and thorough cultivation of wide fallowed intervals between adjacent triplet rows a foot apart from one another; these wide intervals, a yard in breadth, are at once the feeding ground of this year's crop, and the seed-bed of the next. This cultivation, as conducted by Mr. Smith, costs 7*l.* 3*s.* 9*d.* per acre, including rent and taxes (2*l.* 4*s.* 3*d.*), and it results in obtaining from what is really half the land a crop which would generally be considered a good one though taken from the whole of it—and this it yields annually and constantly. For a full account of the process and its result, the reader is referred to Mr. Smith's publications on 'Lois Weedon Culture' (Ridgway); both are referred to here as among existing agricultural maxima, though, like many another exceptional experience, they may be copied largely over the wheat soils of this country by all who shall carefully as well as

intelligently carry out the full instructions and explanations which Mr. Smith has given.

These, then, are the few instances for the present given of our largest yields of agricultural produce. They are worthless for statistical purposes—they have done little to raise the average of the national produce, and, indeed, excepting such cases as the last, which, though extraordinary as compared with general agricultural experience, are constant in the experience of the individual cultivator, they have done little, in the long run, to mark out those who have communicated them from their neighbours. Though of little value, however, to the statist, they ought to teach some useful truths; and this they are capable of doing just in proportion to the fulness of the history which has been given of them.

Perhaps the most general lesson which they teach is that the natural method of fertility is, after all, the most efficient. As Mr. Cubitt tells us, it is the fertile season, rather than the artificial treatment of the land, that results in a maximum of produce. And just in proportion therefore as this artificial treatment imitates the conditions of the natural, success will be its return. All the cases of extraordinary yield from land recently taken out of pasture, from crops liberally irrigated, and, as at Lois Weedon, from soils so treated as to give full scope to the fertilising agencies of nature, point to the subdivision and complete admixture of our manures, as well as of our soils, to the use of such implements for this purpose as the water-drill, and to such deep and thorough tillage of the land as in the ordinary experience of fallowing has everywhere and always been admitted to be among the most efficient means of artificial fertility.

Streatley, Reading.

XXIV.—*On Pulping Roots for Cattle-Food.* By Charles Lawrence.

Many years have passed since our attention was directed to the universal and, as it appeared to us, irrational practice of farmers, in giving animals large quantities (from one to two hundredweight per diem) of neat roots containing 90 per cent. of water, the more solid dry food being given independently. When we commenced the feeding of animals, we could not reconcile that practice with the animal economy. We reduced the maximum allowance of roots to 70 lbs. per head a-day for bullocks, and gave this at the morning and evening feeds as intimately incorporated with chaff as was practicable by the root-cutter of the day which most effectually reduced the roots. This was

Moody's, manufactured by Carson of Warminster, which divided the roots into mere ribands. We found such decided advantages in this system—in the economy of roots, in the condition and thriving of the animals, in the diminution of the litter required, and in the nature and quality of the manure—that we could not hesitate to recommend the adoption of it to our neighbours, and particularly to our friend Mr. Edward Bowly, of Siddington (author of the intelligent and very useful article on the Management and Breeding of Cattle, in the nineteenth volume of the Journal), whose farm adjoins our own. He at once adopted our view of the matter; and, after a year's experience, he informed us he was satisfied that it enabled him to keep one-third more stock on his farm, all other circumstances remaining the same. We considered this testimony warranted us in calling more general attention to the subject; and we did this, giving the reasons on which our views were founded, in a short paper which we sent to the Journal Committee of our Society in 1854, and which appeared in the Journal of the following year.

Although the chaff, to a certain extent, adhered to the surface of the thin slices of the roots effected by Moody's machine, we considered a more intimate incorporation desirable. We suggested to some of the implement-makers the want of a machine which would reduce the roots to a pulp, or, at any rate, which would effect a greater reduction of them than could be accomplished by any existing implement. No attempt of the kind having been made, we recommended to our Society to offer a prize for such a machine. They did accordingly offer the small prize of 3*l.* This produced the only pulper, which was exhibited by Mr. Phillips at the Lincoln meeting, at the cost of 11*l.* 11*s.* This the Judges reported as having well broken the roots, but as not producing a perfect pulp. We saw that the cost of this would be a bar to its general use, but it has been much simplified and improved; and a machine was exhibited by the Messrs. Woods, of Stowmarket, at the Warwick meeting, at the cost of 4*l.* 15*s.* only. We infer that this mode of feeding has met with much favour amongst our agricultural brethren, from the fact that, while only one imperfect implement was exhibited in 1855, sixteen were exhibited at the Warwick meeting in 1859.

The first pulper which accomplished the work satisfactorily, and which was exhibited at the ordinary price of the cutters in general use, was Mr. Bentall's, of Heybridge, in Essex. This we procured, on the representation that it could be worked by one man. We found it an effective machine, and within one man's power to satisfy a very small stock, but certainly not enough for our fatting bullocks, usually 24 in number. We got a second handle attached to the spindle on the opposite side, and our feeder and

his lad now pulp all the food required for these bullocks. This thorough incorporation of the roots with the chaff has been so successful with the bullocks, that we are desirous of adopting it for the fatting and store sheep, and for the ewes while at home for the yeaning; and as we get the steam up every week during the fatting season for threshing, chaff-cutting, and other purposes, we have obtained from Mr. Bentall a more capacious machine, to which we have attached a strap from the shaft of the engine. This enables us to pulp roots in any quantity in the course of the day, at so small an expenditure of power as not to interfere sensibly with any other simultaneous operations. We have not had any opportunity of trying, nor of seeing in work, any other pulper than Bentall's; there may therefore have been others introduced of equal or superior merit: indeed, in the Warwick catalogue, Messrs. Wood and Son introduced Mr. Phillips' pulper (to which we have adverted) in these terms,—"This implement is now perfected, being the *Champion of England;*" nevertheless, the last prize given by the Society was at the Chester Meeting, and that was awarded to Mr. Bentall.

We find that, taking a score of bullocks together fattening, they consume per head per diem 3 bushels of chaff mixed with just half a hundredweight of pulped roots, exclusive of cake or corn; that is to say, rather more than 2 bushels of chaff are mixed with the roots, and given at two feeds, morning and evening, and the remainder is given with the cake, &c., at the middle-day feed, thus:—We use the steaming apparatus of Stanley, of Peterborough, consisting of a boiler in the centre, in which the steam is generated, and which is connected by a pipe on the left hand with a large galvanized iron receptacle for steaming food for pigs, and on the right with a large wooden tub lined with copper—in which the cake, mixed with water, is made into a thick soup. Adjoining this is a slate tank of sufficient size to contain one feed for the entire lot of bullocks feeding. Into this tank is laid chaff, about one foot deep, upon which a few ladles of soup are thrown *in a boiling state;* this is thoroughly mixed with the chaff with a 3-grained fork, and pressed down firm; and this process is repeated until the slate tank is full, when it is covered down for an hour or two before feeding-time. The soup is then found entirely absorbed by the chaff, which has become softened, and prepared for ready digestion.

We continue the use of rape-cake as the most economical food, notwithstanding all that has been said and written against it. There is doubtless more or less mustard-seed often grown with the foreign rape-seed. The essential oil generated from the former by the chemical action hereafter explained would be injurious to animals; but we have found this adulteration to be

rendered quite harmless *when exposed to a temperature of* 212°—the boiling-point, and the soup allowed to simmer a few minutes at that temperature before it is thrown over the chaff. Our adoption of rape-cake has been based on the comparative analysis by Dr. Voelcker, given below,* as the average result of his examination of several samples of each. These analyses, it will be seen, exhibit very little difference in the feeding value of linseed and rape cake, while the market value of the one is usually double that of the other. Our experience of the use of rape-cake, thus used, extends over a period of ten years of feeding from 20 to 24 bullocks annually. We have not had a single death during that period, and the animals have been remarkably free from any kind of ailment. Rape-cake not being so palatable to animals as linseed-cake, we do not exceed 4 lbs. per head per diem; and we add in the trough of each animal, with each midday feed, 2 lbs. of mixed meal. We rarely exceed this allowance, excepting in the case of very large oxen; we commence with 1 lb. of cake per head, and increase this gradually up to 4 lbs., when we begin mixing the meal.† We have found the cost, on an average, including attendance and fuel, to be 6*s.* per head per week, exclusive only of the cost of the chaff-cutting. One man and a lad, at 18*s.* per week, pulp the roots by a hand machine, and feed, litter, clean, and cook the food for 23 bullocks, and cut and steam the roots for and feed 24 fatting pigs, having the chaff only cut to their hands. This just fully occupies their time.

Though the nature and use of oil-cakes have no immediate relation to the subject of pulping roots, yet, as they are in practice allied as food for stock, the following digression from our immediate subject may not be unacceptable to our readers. About five years ago we were somewhat perplexed by observing, in the preparation of our midday food for the bullocks, much difference in

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	Linseed-cake.	Rape-cake.
* Moisture	12·44	10·68
Oil	12·79	11·10
Nitrogenized flesh-formers	27·28	29·53
Heat-giving substances	41·36	40·90
Mineral matters (ash)	6·13	7·79
	100·	100·

† The manufacture of an extended quantity of the best manure being a great object with us, we do not hurry the progress of the cattle to maturity for the butcher; but with animals that do not feed so fast as others, or when we have been later than usual in putting them up, we have added 1 lb. of cake and 1 lb. of meal to the above allowance, and distributed the compounds over four feeds instead of three;—the chaff and pulped roots early in the morning—the cooked food, containing 2½ lbs. of cake and 1½ lbs. of meal—then pulped roots and chaff—and last a second feed of cooked food as before, allowing four hours' interval between each meal.

the smell on different days while using the same cake, and also simultaneously in the appetite of the animals for their feed. It was soon perceived that this did not happen on those occasions on which the process of dissolving the cake had been continued beyond the *boiling-point.* We thought this an interesting fact, and that it would be desirable to ascertain the cause of this, as the investigation might lead to further information as to the composition of the cake. We therefore mentioned the circumstances to Dr. Voelcker at the time, who, after a careful examination of the subject, sent us, in the spring of 1855, the following very interesting Report:—

"I believe the pungent principle in rape-cake arises from the presence of mustard-seed, which is often contained in considerable quantities in foreign rape-cake. Mustard and rape belong to the same family of plants; and in Germany, at least, I am sorry to say our rape fields are often very foul with mustard. That boiling water prevents the pungent, acrid smell, is fully explained by the chemistry of mustard-seed. That seed does not contain any volatile or essential oil of mustard, the cause of the pungency of mustard taste; but it does contain two peculiar principles, which, in contact with cold or tepid water, generate essential oil of mustard: the one is called by chemists 'myronic acid,' the other 'myron.' The latter is a substance like albumen, and when moistened with cold water acts as a kind of ferment upon myronic acid, producing the acrid oil of mustard; whereas boiling water coagulates myron like albumen. In a coagulated state myron loses its efficacy as a ferment, and consequently no pungent or acrid smell is produced when cake containing mustard is mixed in boiling water. I am not aware that clean rape-seed contains analogous principles to those in mustard; but, as this is possible, I shall be glad if you will send me a few ounces of decidedly clean rape-seed. A few experiments with such rape-seed will soon tell me if it contains substances allied to myronic acid and myron in mustard-seed, or if (which I expect to be the case) your rape-cake is made from seed containing a mixture of mustard-seed.

"However, the practical result of mixing rape-cake with boiling water deserves to be generally known, for even pure mustard-cake will lose its poisonous character—or, more correctly speaking, its poisonous qualities will not be called into existence—if it be mixed with water at the temperature of 212° Fahrenheit.

"An analogous case is presented to us in bitter almonds. There the albuminous substance which acts as a ferment in contact with water is called 'emulsin.' Besides this emulsin, bitter almonds contain a beautiful crystalline substance called 'amygdalin.' Neither the emulsin nor the amygdalin is poisonous, neither have they any smell; but when both are mixed together in cold water the emulsin resolves the amygdalin into volatile or essential oil of bitter almonds, and into hydrocyanic or prussic acid. Digested with cold water, bitter almonds gradually generate oil of bitter almonds and prussic acid; digested with boiling water, or heated by themselves to the temperature of 212° Fahrenheit, the emulsin in almonds coagulates, and no oil of bitter almonds or prussic acid is formed."

We hope to see, and we doubt not we shall see, the pulping system, with a due admixture of chaff, universally adopted for bullocks, horses, and sheep, as soon as the friction of the machines has been so far reduced as to render them as easy in

work to the carters and shepherds as the old turnip-cutters. Our confidence in the advantages of this system has been much increased by the extensive adoption of it since the recent introduction of Mr. Bentall's and other pulpers, of which we have unmistakeable evidence in a small pamphlet of Mr. Bentall's, which has come under our notice within a day or two. This contains a selection of 400 reports from agriculturists from various parts of England, Scotland, and Ireland, who have adopted and borne their testimony to the benefits they have derived from it.

[Statements of experience have been received from many who have adopted the practice of pulping roots, and they almost universally assert its economy and advantage. These might have been arranged in tabular form, as was done in a former volume of this Journal (vol. iv.), with a series of testimonies to the advantages of Crosskill's clodcrusher, but it has been thought better to select a few of the most detailed and explicit of the reports, and publish them in full.—J. C. M.]

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1. *From* Mr. J. B. Wright, *Hedderwick-hill*, *Dunbar*, *N. B.*

Being impressed with the idea that roots, such as turnips and mangold wurzel, are given to stock in too great quantities without a corresponding benefit, and that, were more fodder introduced amongst their food in a palatable form, the animals would thrive equally well on a more economical diet, the reporter purchased at Carlisle, when the Royal Agricultural Society's meeting was held there in 1855, a "Phillips' Root-mincer," made by Woods, of Stowmarket, which gained the first premium. Being made for power, it was attached to the steam-engine, and since that has worked to the satisfaction of all who have seen it. Without entering into any minute description of the machine, it is sufficient to say that it tears the roots into shreds, the juice of the turnips being retained by the particles torn off. These are then mixed with cut straw or wheat chaff, and, by lying an hour or two together, the fodder gets incorporated with the pulp, rendering it so palatable that stock eat it greedily.

Two lots of year-old cattle were fed: the one in the usual way—sliced turnips and straw *ad libitum*, the other with the minced turnips mixed with cut straw. The first lot consumed, each, daily:—

84 lbs. sliced turnips,
1 lb. oilcake, }
1 lb. rapecake, } broken small and mixed,
½ lb. bean meal, }

with a little salt, and what straw they liked. The second lot ate, each, daily:—

50 lbs. minced turnips,
1 lb. oilcake,
1 lb. rapecake,
½ lb. bean meal,

and a little salt, the whole being mixed with double the *bulk* of cut straw or wheat chaff. In spring, the lot of cattle which had the mixed food were in as good condition and equally well-grown as the others, though they had consumed in five months two tons less of roots apiece.

The reporter does not advise the mincing process to be commenced when cattle are very forward in condition, as any change of food requires a certain time to accustom the animals to it, and in the mean time fat cattle are apt to fall off in condition. It ought to be begun when they are young and lean.

Swedish turnips, when given to ewes in lamb, are found to cause inflammation, and frequently death; and last season the reporter, having upwards of 200 great ewes, with little else than Swedes to carry them through the winter, thought that, by mincing them and mixing with cut straw, they would do well—which was the case. As with the cattle, *double the bulk* of cut straw was put amongst the turnips, and carted to boxes laid on a grass field every morning and evening, and the quantity of roots consumed was much less than in the ordinary way of spreading whole turnips on a field, while the condition of the sheep was kept up by the quantity of fodder they ate, which they would not have done by any other process.

It is well known that the stomach of a ruminating animal must be filled previous to chewing the cud, and if that is done by a system of mixing the roots and fodder, it gives the animal more rest, which is essential both to feeding and breeding. The food so prepared keeps well for three days, so it is seldom the steam-engine has to be put on for the purpose of mincing alone; as, during the feeding season, when corn is generally threshed, an hour or two of extra steam answers the purposes of mincing and cutting straw, both of the machines going at the same time. Two men are required, one to feed the machine and the other to shovel it away; the time necessary to cut a cartload being a few minutes.

In conclusion, the reporter may add he believes the machine will be extensively used and approved of, and he has no doubt it will come into more general use: having for its great object economising of roots, and causing a larger quantity of straw to be consumed as food, it is well worthy to be tried by our intelligent agriculturists.—Nov. 14, 1859.

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2. *From* Mr. A. S. Ruston, *Aylesby House*, *Chatteris*.

I have adopted the pulping system for the last few years successfully. My usual practice has been to cut either oat or wheat straw with about one-fourth hay (mown seeds) into chaff for my store bullocks. In some instances I have cut straw only, and that not unfrequently of a coarse, inferior quality, as is the case with most of ours grown upon fen lands. The same remark will also apply to the hay. With this chaff I have put from one to two pecks of pulped mangolds, and, after properly mixing it, have given it at once to the cattle without fermentation. With this mixture they have also had a small allowance of cake. I find the bullocks will eat this mixed food greedily, and will consume very large quantities of it; whereas, were the chaff and mangolds given separately, they would eat but very little indeed of the former, unless it were made much better in quality, whilst they would hunger after the latter, and keep in an unsettled state during a great part of the day.

I therefore find, as the result of this system, that the cattle are tempted to consume a much larger quantity of inferior food than they otherwise would do, and that they eat it with an evident relish, and also take their rest more regularly; the consequence of all which is, they thrive much faster. The stomach being properly filled and distended with this common and inferior food, and digestion being stimulated and excited thereby, the animal is the better enabled to assimilate those more costly and more fattening qualities of food which are supplied in the form of cake, &c. Pulping is also economical as regards the roots themselves. A smaller quantity on this system suffices, and produces results more satisfactory than a larger quantity would on the old system. My experience is confined chiefly to growing steers. I feed but

few bullocks, my natural food not being good enough; but I usually buy store cattle, chiefly Scots, and improve them from 3*l.* to 4*l.* per head during the winter, and sell them at Norwich in the spring.—Dec. 14, 1859.

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3. *From* Mr. Joseph Pollard, *Highdown, Hitchin.*

I have used a pulping machine (one of Bentall's manufacture) for the last three years, and so approve of the system that I have purchased another machine this year. Hitherto I have only used pulped food for neat stock, but am now trying its effect upon pigs also, with the hope of saving a large portion of the meal. I have adopted the plan of rearing my own cattle, weaning the calves, grazing them two summers, and fattening them off, and calving the heifers before the third. During the winter months the store cattle of all ages have nothing but an abundant supply of pulped roots (Swede turnips in the early, and mangolds in the later months), with straw chaff, and "cavings" when we thresh. Last year I was very short of roots, and was obliged to limit their quantity and substitute meal instead. This year I am very fortunately well off for roots, and the store cattle have had nothing but pulped roots and straw chaff; and they have done quite as well, if not better, than last year. The fatting stock have meal and oil-cake ground small, which is then mixed with the pulped food and chaff, and all thoroughly incorporated together.

I invariably use the roots *fresh*, and have done so well that I do not intend trying the fermentation process again, not having succeeded with my first experiment. I have never used any pulped food for horses, nor for sheep; indeed, for the latter, I think Gardner's Turnip Cutter a more useful implement, for, in dirty weather, it is quite impossible to prevent a great deal of dirt being mixed up in pulping the roots, which, on many farms, would not fail to produce scouring, &c.; whereas, by the other machine, the dirty outsides are rejected by the sheep, and left in their troughs. There can be no question, I think, as to the advantage of preparing roots in this manner; there is no waste, all being cleaned up well after every feed. The time gained by the animal in digestion, by having highly comminuted food given to it, is very important, particularly with fatting stock. I have never yet steamed the food: I cannot think it necessary for ruminants; it may possibly answer for pigs and horses, but cattle have their food so long macerating in the first stomach, that, provided it is given finely mixed and minced, I cannot but think it more natural than to cook it for them. In conclusion, I may add that, since I used the pulper, the meal has never hoven or blown any stock, which was not unfrequently the case formerly, when meal was given with chaff only; and the impossibility of an animal choking itself is also a very important point.—Dec. 21, 1859.

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4. *From* Mr. James Beadel, 25, *Gresham Street, London.*

I regret I cannot give you accurately the result of the experiments I have made with pulped food for horses, sheep, or cattle. My only object was to satisfy myself; and, after using pulpers three or four years, I have arrived at the conclusion that they are a far more valuable implement than any root-cutting machine. I have no doubt as to the economy of pulping, the result of which is a great saving of hay, none of which do I ever use for store cattle, nor even for those I fatten till they are within a few weeks of maturity. The ingredient I use with pulped roots is straw, having them mixed and turned over 24 hours before they are given to the stock; 1 bushel of roots to 2 bushels of cut straw-chaff. In proportion as I wish to force the animal, I add to the mixture a certain portion of oil-cake or malt-dust, barley or bean-meal. During the four years I have pulped, my stock has been remarkably free from

disease of all kinds; still I am bound to say I consider this immunity is more due to the protection I afford my stock than to the food I give them. The result with me has been the same whether the animals have been old or young, fat or lean; and I believe the most economical way of feeding cart-horses will be found in giving them a large proportion of their victuals in pulped roots and cut straw-chaff. I have found pigs of all ages do remarkably well upon pulped roots mixed with meal or pollard.—Nov. 29, 1859.

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5. *From* Mr. J. Blundell, *Bursledon, near Southampton.*

In reply to your inquiry of my experience in pulping roots for stock, allow me to say that I only advocate it for horses and pigs, and then only for the purpose of mixing other feeding materials.

For the last three years we have fed for pork above 100 pigs in each year; and, although I have no experiment to offer as compared with other modes of feeding, our plan is simply to pulp mangold and mix with barley-meal, giving at the onset only a small quanity of meal, but increasing the quantity as the pigs advance in condition, and during the last 14 days of feeding giving meal only. I prefer this plan to any other I have seen, and I reckon that pork can be made in this manner 15 per cent. cheaper than by meal only; and the process of feeding being slower, it certainly gives a larger quantity of manure. I feed a good number of beasts every year of different ages, and I feed them with mangolds or carrots, cut with Gardner's Cutter, as for sheep, and mix bean and oil-cake with the cut roots; and in this way the bullocks eat a good lot of long oat-straw. This is an inexpensive way of feeding, and answers well where straw is plentiful.

I do not advocate pulping roots, except in cases where the economy of straw or hay is important.—Dec. 17, 1859.

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6. *From* Mr. E. Corner, *Woodlands, Holford, Bridgewater.*

I have adopted the system of pulping my roots for the last four or five years, and the more I use it the better I like it, for I really believe I can keep one-third, if not half, the quantity of stock more, and keep them in better *condition*, than on the old plan; of course I make a free use of one of Cornes's *largest* size chaff-cutters, which is driven by steam, together with the pulper and other machinery. I believe the *slow motion* of hand-power will not pay to use for a large or moderate quantity of stock.

My plan is, first commencing with the grazing beasts, to cut about an equal quantity of hay and straw and mix with a sufficient quantity of roots (mostly mangold) to well moisten the chaff; and as the beasts advance in condition, I lessen the straw and increase the hay, and in their further progress I mix—in addition to all hay chaff and roots—from 6 to 10 lbs. per day to each bullock of barley and bean-meal, according to its size; and I have them large sometimes—I sold last week for the London market a lot of Devon oxen, of very prime quality, averaging in weight upwards of 100 stone imperial each.

For my horses, cows, yearlings, and oxen—the latter to be kept in a thriving condition, and turned to grass, and kept through the summer for Christmas 1860—I cut nearly all straw with a very small quantity of hay, and this the offal of the rick. These also have as many pulped roots as will moisten the chaff, except the horses, and to them I give, along with *bruised oats*, just enough roots to keep their bowels in a proper condition. To the two or three year old beasts I give some long straw and a part chaff, and the offal (if any) of the food of the above lots of stock.

My farm is but a small one, under 200 acres. My predecessor always

mowed nearly all the pastures for hay, which is about half the farm, and with this scarcely ever grazed any beasts, and kept but very few sheep. Since my occupation I scarcely ever exceed 10 acres of meadow with one field of seeds for hay. I keep from 250 to 300 large-size Leicester sheep, and graze from 20 to 25 large size beasts a year, with other breeding stock in proportion.

I consider the pulping of roots is better for fatting pigs than anything else. My plan is to have a large two-hogshead vat as near the pulping-machine as possible, so as to fill it with a malt-shovel as it comes from the machine; at the same time I keep a lad sprinkling meal (either barley or Indian corn) with the roots, and this is all done in 15 or 20 minutes: it is then ready for use to be carried to the pigs in the stalls alongside the fatting beasts. I never could fat a pig with *profit* until I used pulped roots.

I get up steam to use the machinery and mix the chaff and pulped roots twice a week.—Dec. 14, 1859.

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7. *From* Mr. M. Slater, *Weston Colville, Cambridgeshire.*

I would not be without the pulping-machine upon any account. I give all my cart-horses a bushel per day of pulped mangold, mixed with straw and corn-chaff. I begin in September, and continue using them all winter and until late in the summer—nearly, if not quite, all the year round; beginning, however, with smaller quantities, about a peck, and then half a bushel, the first week or two, as too many of the young growing mangold would not suit the stock. I believe pulped mangolds, with chaff, are the best, cheapest, and most healthy food horses can eat. I always find my horses miss them when I have none, late in the summer. I give them fresh ground every day. Young store-beasts, colts, &c., do well with them; but I do not think they could be used with any advantage with a flock of sheep: they are, however, useful for fattening bullocks, inducing them to eat any food you may wish to give them. —Nov. 26, 1859.

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8. *From* Mr. C. Woolfield, *Balquhain, Kilmarnock.*

The machine I purchased cut the turnips about the size of a horse-bean. In the winters of 1855 and 1856 I fed 150 sheep confined in sheds with sparred wood floors, in pens of about 10 in each, with a space of four feet underneath, and about three feet of dry peat-earth laid down under the sparred flooring. My plan was to crunch a quantity of turnips with the machine, put a layer of cut oat-straw and hay, half and half, on the floor, about one foot deep, covering a space of eight feet long by four feet wide, and placing over this a layer of the crunched turnip about one foot deep, and so on alternately to about two feet high. I then sprinkle with a little salt, throw three or four buckets of water over it, trample, and beat the sides and top with a shovel. In three or four days it will heat, and in that state sheep are very fond of it. To this mixture I added linseed and bruised oats, and gave them as much as they would eat. I had a bed of the mixture made daily, so that it was always in a fermented state for use. The sheep ate it with great avidity, and became fat. My sheep were of the black-faced Highland breed, and I think did not feed so rapidly as Leicesters would: they were *two* and *three* years-old wethers, taken from high ground I had in Argyleshire. They were some weeks before they properly commenced eating, but throve rapidly afterwards.

I think this mode of using turnips profitable; but I did not test it against feeding on the field—the climate here is so wet, and the ground so unsuitable, that it would be out of the question without shelter and old pasture—but I should say the saving of turnips would be more than half. I am giving the same

mixture to dairy cows and young stock with a little rape and oil-cake; also to my farm horses.

The machine I had was the small size (Wood's) for hand-power, but I put a pulley on it and took a belt from the drum of my threshing-mill. I would have preferred one of a much larger size.

I may state that the sheep continued very healthy, and there were no deaths after the third week; their feet continued sound, and there was no foot-rot, as when standing upon stone.—Nov. 29, 1859.

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9. *From* Mr. John Watson, *Agent to the* Earl of Macclesfield, *Shirburn Castle, Tetsworth, Oxon.*

We have used pulped roots for all our cattle these five years.

For the fattening cattle we mix about four bushels of pulped roots with five bushels of cut chaff. The store cattle have a mixture of about three bushels of pulped roots to six bushels of chaff. Good sweet barley or wheat chaff from the threshing machine is used for the stores instead of cut chaff, and all have as much of their mixed food as they will eat clean up.

I find the cattle thrive well, and improve much faster than they would with the same quantity of roots given to them either whole or sliced and given twice a day as we used to do. The chaff and roots are mixed from 14 to 24 hours before they are given to the cattle, and get pretty warm.

Of course we do not expect that the pulping adds to the nutriment of the roots, but the mixing with chaff prevents scouring in the cattle, particularly in the use of mangold wurzel; and, though I have not entered so accurately into the weight and measure of the saving as might be desirable, I am satisfied with the progress the cattle make while fed with the mixture above described, and believe the saving in the quantity of roots to be about one-fourth.—Nov. 29, 1859.

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10. *From* Mr. T. Duckham, *Baysham Court, Ross, Herefordshire.*

The advantages of pulping roots for cattle are—1st. Economy of food; for the roots being pulped and mixed with the chaff either from threshing or cut hay or straw, the whole is consumed without waste, the animals not being able to separate the chaff from the pulped roots, as is the case when the roots are merely sliced by the common cutter: neither do they waste the fodder as when given without being cut.

2nd. The use of ordinary hay or straw. After being mixed with the pulp for about 12 hours fermentation commences; and this soon renders the most mouldy hay palatable, and animals eat with avidity that which they would otherwise reject. This fermentation softens the straw, makes it more palatable, and puts it in a state to assimilate more readily with the other food; in this respect I think the pulper of great value, particularly upon corn-farms where large crops of straw are grown, and where there is a limited acreage of pasture, as by its use the pastures may be grazed, the expensive process of haymaking reduced, and consequently an increased number of cattle kept. I keep one-third more, giving the young stock a small quantity of oil-cake, which I mix with the chaff, &c.

3rd. Choking is utterly impossible, and I have only had one case of hove in three years, and that occurred when the mixture had not fermented.

4th. There is an advantage in mixing the meal with the chaff and pulped roots for fatting animals, as thereby they cannot separate it, and the moisture from the fermentation softens the meal and insures its thorough digestion; whereas, when given in a dry state without any mixture, frequently a great portion passes away in the manure.

I have tried it for feeding pigs, but have gone back to the old system of boiling or steaming the roots. Pulping them before steaming very materially assists the process.

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11. *From* Mr. W. Sadler, *Ferrygate, Dirleton, East Lothian.*

My experience of the system of mincing or pulping roots for cattle extends to some trials made with feeding cattle; one lot of four short-horn steers having been fed by me upon as many sliced Swedish turnips as they could eat; and another lot, the same in number, upon a mixture of cut wheat-straw and fresh pulped swedes, *ad libitum*. It was found that the lot on pulp would not consume above 7 lbs. weight of cut straw per diem. Both lots of cattle were weighed at the commencement and at the end of the experiment, and a careful account was kept of the weight of food consumed.

The lot on sliced food was found to have eaten, in 88 days, 25 tons 1 cwt. 2 qrs. of swedes, and to have increased in live weight 7 cwt. 31 lbs.; and if 6*d.* per lb. be taken as the value of the increase of their live weight, the sum would amount to 18*l.* 2*s.* 6*d.*, as a return for the quantity of swedes consumed. The cost of slicing and attendance on this lot was 16*s.* for the whole time, so that the return per ton for swedes consumed amounted to 14*s.* 6*d.*

The lot upon pulp consumed in 88 days 23 tons 13 cwt. 1 qr., and they only increased in live weight 6 cwt. 46 lbs.; and if the above rate per lb. be also taken as the value of the increase, the amount of return for the food consumed will be 15*l.* 17*s.* 6*d.* The expense of pulping, cutting straw, &c., for this lot amounted however to 1*l.* 11*s.* 6*d.*, from which has to be deducted 14*s.* as the value of the extra turnips eaten by the other lot, so that those on pulp thus left only 13*s.* 6*d.* per ton, being 1*s.* per ton less. The lot on sliced food had access to the same straw as the others, but uncut; and both lots had an allowance of oil-cake during the last four weeks of the experiment.

It is hoped no one will presume the pulping system to be unworthy of adoption in the fattening of cattle from the fact of a single trial having proved unfavourable, as we all know that in a lot of beasts even one animal, from being a dull feeder, will effect a difference in a trial of this sort. In this particular instance all seemed to thrive and feed very equally.

I have directed my attention now to giving reduced quantities of pulped turnips, along with more chopped straw, oil-cake, and other substances; and I have at present a trial going on with beasts receiving 84 lbs. of pulped swedes, 14 to 20 lbs. of cut straw, and 4 lbs. of oil-cake, against cattle receiving full allowance of sliced swedes, or about double the amount of the above.

As regards the value of the pulping system when applied to store or wintering cattle, there cannot, I infer, be a doubt, from any one that has tried it, but that it is one of the most economical discoveries of the age. I have at present 50 beasts on pulp, some in store, and others in part feeding condition, each class receiving their weighed allowance of pulp and "chop" according to their ages and sizes. One of the many advantages of feeding in the pulp, where cattle are kept in large open courts with sheds attached—such as they are in East Lothian—rests in being able to increase the bulk of food so much that the stronger beasts fill themselves and lie down, allowing the weaker animals to have a full supply; whereas when cattle receive a reduced quantity (often as much, I suspect, as would do them good) the strong ones generally knock the weaker ones about, and rob them of their fair share. I find young beasts improve well upon 28 lbs. of pulp, besides straw and 2 lbs. of oil-cake, with 2 lbs. of rape-cake mixed. I tried fermenting, but did not find it answer well, either with pigs or cattle, when tried against other feeding substances. I prepare daily as much pulp as lasts for 24 hours. The machine used by me is Bentall's, which *plucks* the roots and does not express their juices unneces-

sarily. It is driven by a small fixed donkey-engine, made by Mr. R. Bridges, of North Berwick, at a cost of 20*l*., exclusive of boiler and pump, which are extra-sized for steaming food and for supplying my establishment with water. —Jan. 9, 1860.

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12. From Mr. PETER M'LAGAN, *Pumpherston, Mid Calder, N. B.*

According to promise, I send you a few notes of my experience in the pulping of turnips.

As the greater part of my cattle are kept in winter in courts of different sizes, capable of containing from four to twelve cattle each, I had always a difficulty in regulating the quantity of turnips for each description of stock. If the cattle were to be fattened off, they became restless if they did not get as many turnips as they could eat; if they were supplied with what they could consume, they suffered from diarrhœa. Thus for the first four or six weeks after they commenced to get turnips they fell off in condition, either from restlessness or from scouring. If the cattle were only to be wintered, or to receive one-half turnips, the stronger ones in the lot got more than their share, while the weaker were scarcely allowed to taste a turnip. I resorted to various methods to try and remedy these evils, but succeeded in none till I procured one of Bentall's root-pulpers and one of Richmond and Chandler's straw-cutters, both of which I attached to my water-wheel by means of a lying shaft. As I had not determined how far I would carry out the pulping system, I did not erect separate buildings for the operation, but merely portioned off a part of the straw-barn, so that I was rather limited in room; but it was sufficient for my purpose, as I wished to satisfy myself as to the advantage of the system before adopting it for the feeding of all my stock.

I use all my oat-chaff and some of my wheat-chaff for mixing with the pulped turnips, and when I am short of oat-chaff I cut oat-straw for the purpose. All kinds of stock are fondest of the mixture when made with oat-chaff. Sometimes I mix with the turnips and chaff bean-meal, Indian corn-meal, rape-dust, linseed-cake, flour, &c. I prefer using the mixture after it has lain from 18 to 24 hours; but the animals do not object to it though it may have been made up for more than 48 hours. When such substances as rape-dust are mixed with it, a very rapid fermentation takes place, and if it is not attended to in time, much valuable food will be wasted. The pulper gets through much more work than the straw-cutter—the usual rate of pulping being one ton every twenty minutes. This is the most convenient rate for the force of women I engage at the operation; but I have very easily done three tons in half an hour. The turnips are washed when they are dirty; but if they are lifted clean in dry weather they are not washed. The expense of pulping, cutting straw, and mixing the two together, with the addition of 18 stones of meal to every $2\frac{1}{2}$ tons of turnips, amounts to from 4*d*. to 6*d*. per ton of turnips, according to the kind of turnips, and whether they are washed or not: 10 per cent. on the prime cost for the tear and wear of the machinery is included in the 4*d*. or 6*d*. The rule for mixing the ingredients is to fix the quantity of turnips to be given, and to add whatever quantity of chaff or straw may be necessary to satisfy the animals.

Wintering, or Store Cattle.—They are generally about two years old. From 56 to 60 lbs. of pulped turnips, mixed with about 8 to 10 lbs. of chaff or cut straw, are allowed to each per day, and they get besides as much oat-straw in "hecks" or cribs as they can consume. As I stated before, I have made no experiments; but I have more than once observed that I have been able to sell fat those cattle which I wintered on $\frac{1}{2}$ cwt. of pulped turnips as soon as those which got 1 cwt. of whole turnips the winter before I fattened them. My practice is to buy my store cattle in November, keep them throughout the

winter as described above, graze them during the summer, and sell them off fat about the month of February thereafter. They do not get pulped turnips after being put up the second winter before being fattened off, and I have observed that the cattle getting ½ cwt. of pulped turnips the first winter are as soon ready for the butcher the second winter as those that got 1 cwt. of whole turnips the first winter, all other treatment being the same.

Milk Cows.—I have fed my milk cows for a winter on pulped turnips and chaff or cut straw. Those not in milk were allowed ½ cwt. of turnips, and those in full milk 1 cwt. and 2 or 3 lbs. of bean-meal or other supplementary food mixed with the turnips and chaff per day. I observed particularly that neither the milk nor the butter had the least taste of the turnip.

Young Horses.—These were also fed on the pulped turnips and chaff, prepared in the same way as for the milk cows. They consumed at the rate of 1 cwt. of turnips per day, and throve beautifully on the mixture. Before I pulped the turnips they got one feed of boiled turnips per day and as many raw ones as they could consume. There was no difference observed in their condition when fed in either way.

Fattening Cattle.—As the feeding of these with pulped turnips would be very inconvenient, owing to the arrangement of the buildings, I have not tried the plan with them; but I am convinced that it must be attended with advantage if properly followed out. I have repeatedly allowed bullocks, when first put up, to eat as many turnips as they chose to consume, and I have found that frequently oxen that would feed to say 6 cwt. would eat about 3 cwt. per day of white turnips. The effect of such a load in their paunches was soon apparent in the profuse diarrhœa which was sure to follow. I have no hesitation in saying that less than half of that quantity pulped and mixed with chaff or cut straw would, instead of retarding the progress of the fattening process, carry forward the animal in condition. I have no doubts of the advantage of giving a mixture of pulped turnips and chaff for the first six weeks after they are put up to feed. In the experiment published by Mr. Sadler, Ferrygate, he stated that for the first month the "lot feeding on the pulp seemed to take the lead." Probably the result in that experiment would have been more favourable for the pulped turnips if, after the first month, the proportion of chaff or cut straw had been reduced. The reason why feeding with pulped turnips has not been attended with profit, is the great expense attending it. According to Mr. Sadler, the expense of pulping the turnips, cutting the straw, and preparing the mixture, was at the rate of 1*s*. 4*d*. per ton of turnips consumed; and according to one experiment of Lord Kinnaird it was 1*s*. 9*d*. per ton, and according to another 2*s*. 1*d*. per ton of turnips consumed. Lord Kinnaird used a small steam-engine for the operation. I, with my water-power and Bentall's pulper, can prepare the same mixture at from 4*d*. to 6*d*. per ton of turnips.

Ewes.—The number of ewes kept on my farm is about 250, half-bred between the Leicester and Cheviots. They are cast ewes purchased every year, from which the lambs are sold fat and early to the butcher, and the ewes fattened off immediately after. Considering the class of ewes, there is almost a certainty of some of them wanting their teeth. Disapproving of giving them a full supply of turnips, and grudging the expense of feeding them on hay, for which I generally get about 5*l*. per ton, and having always failed in my attempts to make them eat straw, I determined to try the root-pulping system with them. There is generally sufficient grass in my pasture for them till the beginning or middle of December. Whenever the grass becomes scanty, I commence to give them pulped turnips and chaff, at the rate of 10 lbs. of turnips to each ewe per day. This is gradually increased to 15 lbs.—more than which they seldom get till they are lambed, when they are allowed 20 lbs. and upwards, or, in fact, as much as they can consume. About three weeks before lambing I mix with the pulped turnips and chaff brewer's or distiller's grains, bean-meal, crushed oats, or some

other extra food, to bring the milk upon them; and the same feeding is continued after they have lambed till there is a full bite of grass for them. I also allow them a limited quantity of hay some weeks before they lamb. As my object is to have my lambs fat and ready for the market as early as possible, I require to have the ewes in good condition. There is always great risk attending the parturition of ewes in high condition, and that risk is much increased when the ewes have been allowed such a bulky watery food as turnips *ad libitum*. By pulping the turnips and reducing the quantity, I avoid much of this risk, and am able to bring up into condition the old ewes without teeth, save my hay, and get them to eat easily other kinds of food, which they would not have tasted, at least for some time, if they had not been mixed with the pulp. I have derived more benefit from giving the pulped roots to my ewes than from any other kind of stock.

I may mention that both pigs and poultry are very fond of the pulp unmixed with straw; but I have not made a practice of feeding either constantly on it.

I am now so impressed with the advantage attending the pulping system, that nothing prevents my carrying it out more extensively except the present arrangements of my buildings. It is my intention, however, ere long to remove this obstruction by making certain alterations, which will have the effect of facilitating all the operations conducted in them and greatly economizing labour.—Jan. 10, 1860.

XXV.—*Kohl-Rabi: its Cultivation; for what Stock it is best adapted, and to what Extent it can be used as a Substitute for the Swedish Turnip.* By WILLIAM BENNETT.

To H. S. THOMPSON, Esq.

DEAR SIR,—I infer from your communication of the 7th inst. that the Journal Committee of the Royal Agricultural Society are anxious to know by what means the late extensive failure in Swedish turnips may be met, or what other roots can be best substituted for them. You are aware, Sir, that much has been advanced of late to account for this failure, and many remedies have been suggested; but hitherto, it is to be feared, with very little success.

I shall not myself occupy your time by adding my opinion upon the restoration of the Swedish turnip, although I should be very glad to see it accomplished. If, however, you think the following remarks on the cultivation and use of Kohl-Rabi (chiefly founded on my own experience) worthy of insertion in the Journal, and likely to be of benefit to the farming community, they are quite at your service.

I remain, &c. &c.,

WILLIAM BENNETT.

Regent-street, Cambridge, December, 1859.

The botanical name of this plant is *Brassica oleracea caulo-rapa.* There are several varieties of the smaller kind raised in garden cultivation, of a variety of shapes and colours; these are principally for *table purposes,* and are considered very nice vegetables, cooked like turnips, or cut into slices and fried. They make also excellent pickles. They are exposed for sale in the German markets much the same as carrots and parsnips are in England.

The two most important varieties for field cultivation are the *large green, and purple.* Both can be had either of the round or oblong shape, and it is difficult to say which shape or colour is best. We have a *predilection* for the green, whether oblong or round.

The Kohl-rabi seed is extremely difficult to grow true, as it is apt to sport or to be inoculated by bees. It is also generally meagre in quantity. The oblong and round varieties are not usually kept distinct, and it will frequently occur that plants raised from the seed of perfectly round bulbs will grow of the oblong shape. But, whether oblong or round, purple or green, we greatly mistake if it be not shortly regarded as the most valuable of our root-crops. We saw it grown upwards of thirty years ago by that eminent agriculturist the late John Foster, Esq., of Brickhill-house, Bedford, who was accustomed to speak of it in the highest terms. After that gentleman left England for the West Indies; whether from its cultivation not being much understood, or from the just popularity of the Swedish turnip in those days, the cultivation of Kohl-rabi did not much increase. It seemed, indeed, quite unnecessary to seek for a better root than the Swede. It is now far otherwise: we question much if, in the majority of cases, in this and several adjoining counties, Swedish turnips are worth anything like the cost of cultivation. Seeing, then, what a miserably precarious crop the Swedish turnip had become, about five years ago we purchased a little Kohl-rabi seed and sowed it on a seed-bed. The land intended for this crop having been cleaned and manured in the previous autumn, after a crop of tares had been mown and carted off, we gave it one good deep ploughing (using the skim-coulter), harrowed and rolled it, and then set the plants 2 ft. apart by 1½ ft. The land being dry, and not then knowing the hardihood of the plants, we gave them one watering, which, however, we have not since had occasion to do, although we are not sure that, in a very dry season, when water is at hand, 6*s.* or 7*s.* per acre would be thrown away when so applied; as by this means the plants get an immediate start, almost without dropping a leaf.

Our first efforts were quite successful: we obtained a beautiful

crop, which stood the winter well, furnishing very excellent feed for the ewes and lambs through March and most of April. We always in this case adopt the Hertfordshire system, using lamb-hurdles, which allow the lambs to run first, eating the tops with a few cut bulbs, the ewes in the fold cleaning up after them, and, before the Kohl-rabi is exhausted, give a little mangold in the fold. We have seldom had them do so well, and never since have felt any necessity for a change. It is a good practice, however, when in the spring the Kohl-rabi gets hard, to run the offal through the cutter and put it into troughs. The food being always clean, this may be done without inconvenience.

Within the last few years we have abandoned the seed-bed, drilling our general crop on the fallows in May on ridges: the surplus plants will be quite fit for transplanting by the time the green crop is mown off the land which is intended to be subsequently planted with Kohl-rabi; so that by *one* operation we provide sufficient plants for setting, and at the same time leave, properly singled out, enough for the general crop. Light one-horse or donkey carts track the rows close at hand, to receive and carry them off to the parties planting them.

It may be useful here to observe, that the general crop should be drilled on ridges, at some little intervals as to time; because the exact period required to raise the plants will depend more or less upon the weather, and it will take comparatively but few acres from which to draw plants for a considerable area—the surplus plants of a single acre will furnish enough (after casting the bad away) to plant four or five.

Our practice has been, not to drill the Kohl-rabi before the middle of May. It may be wise, however, to commence with some a fortnight earlier if the land is in good order. We seldom use more than about 2 lbs. of seed per acre, drilled on ridges at twenty-seven inches apart, thinning the rows to about sixteen inches from plant to plant.

The mode of cultivation pursued by us has been the same as for Swedish turnips, using about 10 loads or tons of farm-manure and from *a fourth* to *a fifth* of a ton of good artificials, such as blood-manure, superphosphate, rape-cake, or the like, drilled down the ridge or scattered on the manure. We prefer the latter mode, as it spreads the hand-tillage over rather a broader space. By this kind of cultivation, on land worth 30*s.* per acre to rent, we usually grow from 25 to 30 tons per acre of excellent bulbs, besides the tops, which are the best of food; and where a dairy is kept, and tolerably near at hand, they are of no small value to the milking cows, giving no unpleasant flavour to the butter.

The transplanted crop will perhaps be from 5 to 7 tons per

acre less than that grown upon the fallows in the regular way. In addition to the land from which the usual crop of tares has been mown off, we have occasionally planted Kohl-rabi after a crop of Italian rye-grass, alternately, land for land, with drilled rape; feeding the whole off with sheep, which will unmistakeably show you which they prefer. The question is not limited to whether you gain in the single crop more than pays the expense of growing it, as you make in addition a far better preparation for wheat—rye-grass immediately preceding wheat being the worst of all rotations.

If the weather prove favourable, and the operation is completed ere July closes, the crop will more than pay the cost, to say nothing of the incalculable benefit the following wheat crop derives. We simply plough the rye-grass land once, using the skim-coulter and roller, setting the plants down every alternate furrow. Our more experienced farmers would say "a coat of manure would be an improvement;" which is doubtless true, *if it could be had.*

The cost of planting the Kohl-rabi may be taken at from 8*s.* to 10*s.* per acre; much depending, however, on the rate of wages and supply of labour in the neighbourhood. If in a district of market-gardens—where the labourers are accustomed to that kind of work—you may do it for the lower sum, and the labourers will earn good wages; but if among the woods and rooks, the master's eye will be wanted to get it done well even at the higher price. It will be fair to take the average cost at 10*s.* per acre. And when you take into the calculation that scarcely any hoeing is required, the excess in expense over ordinary drilled crops is not serious; more especially when it is borne in mind that they are planted on land where turnips could scarcely be grown, or, if at all, at much greater cost of cultivation.

The next point is *the most approved method of consuming the Kohl-rabi*, &c. Our usual custom is to commence feeding off our drilled crop with the lamb-hogs and cull-ewes in the autumn when wanted.

For the lamb-hogs we should not commence using the cutter before January, except that up to Christmas we want most of the tops for the dairy cows. Whether, however, you cut the bulbs or allow the lamb-hogs to feed the entire crop off the ground, we have not found them do better on any food the farm produces. Any other kind of sheep do on it equally well: our nearest neighbour has for the last two years sent off from his Kohl-rabi the best fat wethers that our Cambridge butchers exhibit, and no small number of them.

We invariably cart off one-third of the crop to the farmstead, where every description of stock—horses, bullocks, cows,

calves, and pigs—eat it most freely, and do remarkably well upon it.

We have hitherto done but little in the way of storing the crop, save to get up a few to carry us through the frost; nor does it seem necessary, for we have scarcely seen a decayed bulb on the farm since we commenced growing it, bearing out the statement of Mr. Stewart, of the Norwich Nursery, that "*Kohl-rabi will stand a severe winter.*" It will this season, however, be severely tested.

Our report so far will be regarded as favourable to the cultivation of this plant. It will be but fair now to notice some of the objections which are urged against it; the principal of which are—first, *that it is a great exhauster of the land;* and, secondly, *that the stalks and roots are both inconvenient and troublesome.*

Taking the subject of exhaustion first, it will be but fair to admit that, with common cultivation, it may pull somewhat harder upon the land than the common turnip: but the question is, to *what extent* you may rely upon receiving value in exchange.

We have already stated that our practice has been to cultivate just as highly as for Swedish turnips, and that from the fallow crop we invariably draw off one-third of the bulbs, and often the greater part of the tops—feeding only two-thirds upon the land; and hitherto, we have had no reason to complain of the succeeding crop of barley. It has not been quite so bulky as after turnips, but stiffer in the straw, and of better quality; the crop last season, in particular, was worth considerably more in value per acre than that after turnips, side by side, in the same field. We come next to the objection as to the stalks and roots, and it will be candid to admit that to a beginner the complaint is not altogether groundless. The stalk running from the root to the bulb is very hard, and if not properly severed from the latter is apt to damage the cutter. This, however, may be easily obviated by a properly made pecker, formed somewhat like a cooper's adze, only not so wide or so much hooked, *and the severance should be made close to the bulb*, when, without the trouble of tailing or cleaning them, a perfectly clean mass of bulbs may be thrown together quite fit for use—a benefit to the sheep which all practical men will know how to appreciate.

The next inconvenience complained of is that the stalks prevent the furrow being properly turned, and interfere with the working of the land. The too general system has been to plough thin, work out the roots and carry them off before sowing the barley. This is faulty in principle, and unnecessarily expensive. Our plan is to send a man over the ground with the same sharp pecker as before, and peck them off close to or a little in the ground—the

stalk (if the stock be good) will not be more than 2 or 3 inches long; then plough all in a little deeper than common; by this means everything is put into a state of decomposition, furnishing a quantity of vegetable manure for the ensuing crops, and avoiding all trouble of extraction. It is worthy of notice, too, that *in no instance have we seen the stalks or roots of the Kohl-rabi sprout again!*

How then stands the question of expense between this crop and Swedish turnips? You have in the former an extra pecking, at the cost, perhaps, of 2*s.* or 2*s.* 6*d.* per acre, while you save on the other hand *all the expense of cleaning, with the consequent remaining dirt and waste incident thereto.* In both cases the tops are presumed to be cut off by a sharp hook while standing. The balance, therefore, in the expense of feeding off, is clearly in favour of the Kohl-rabi, while the value of the food is vastly superior to any modern crop of Swedish turnips.

We have now put the matter, to the best of our ability, before the farming public; we cannot hope all at once to allay prejudice, but it is satisfactory to know that the cultivation of this excellent plant is greatly extending, both here and in the adjoining counties. In Hunts, among others, the Messrs. Bowyer, no mean authorities in the farming world, have been extending its growth every year. Mr. Pawlett, the eminent breeder and feeder of stock, in Beds, has reduced his growth of Swedes this year to one solitary acre; while his brother at Peterborough has been latterly supplying us with the best stock of Kohl-rabi seed we have yet met with: we regret to learn, however, from him that in his last year's crop of seed he has obtained but one bushel where he hoped to get twenty—too truly bearing out our statement that the seed of Kohl-rabi is a very precarious crop. Although it is but five years since we first introduced it into the adjoining parish, there is not a single farmer there who does not now cultivate it; every year increasing the extent—it is in fact now to be seen dotted over this entire county; and it is but honest to admit that on the deeper and better soils there are to be found some few heavier crops than our own, from which bulbs have been exhibited weighing upwards of 14 lbs. each. In reviewing our communication, we imagine our more practical farmers will, probably, think we have gone somewhat further into detail than was necessary, but they will excuse us when we say that we have been requested to furnish information for parties supposed to be thoroughly unacquainted with the plant and its cultivation.

We cannot conclude our remarks without observing that, among all the monotony and other ills of farming life, there is one very pleasurable reflection, viz., that we have no secrets, but—if we know of anything modern or useful—every right-minded agricul-

turist feels pleasure in making it known. If, therefore, there shall be found in the few foregoing pages anything at all beneficial to our farming fraternity, no one will derive greater satisfaction than the writer.

Cambridge, December, 1859.

XXVI.—*Statistics of Live Stock and Dead Meat for Consumption in the Metropolis.* By Robert Herbert.

The last January Number of the 'Journal of the Royal Agricultural Society of England' contained some statements of an important character, in reference to the various changes in the different breeds of beasts and sheep produced for consumption in the metropolis: in other words, we showed that, while some breeds of the former have become nearly extinct as regards the supply for the London market, a wonderful increase has taken place in others, and that our enormous consumption has been steadily met by our breeders and feeders, without leading to very high prices or, considering the amount of animal food actually consumed, any serious—certainly not any very important—drain upon the aggregate resources of the Continent. This drain, as far as Holland is concerned (from which country we have been accustomed to draw fully three-fourths of our foreign supplies since the passing of the present tariff on imports), seems to have reached its utmost limit. We do not say that there is a scarcity of stock on the Continent generally; but it is quite clear that the present stringent regulations at the Custom-house will have the effect of checking shipments of stock to this country, except in a wholesome and consumable state; nevertheless we are still receiving full average *numbers* of stock from abroad, and the deficiency in the receipts from Holland has been made good by extensive arrivals of sheep from Germany—principally Mecklenburg-Schwerin *viâ* Hamburg. We may observe, however, that the total *weight* of meat now imported into England is *considerably* smaller than in many previous years. True, the Dutch graziers, from extensive crossing with some of our best breeds, have at length succeeded in producing a more useful breed of sheep; and they have apparently commenced a system which will prove highly advantageous to them in a pecuniary point of view. Not that the sheep can yet stand the test of competition with half-breds raised even on our poorest soils; but, in a comparative sense, they now begin to exhibit points of much value; and this remark will be more fully understood when we state that some of the best Dutch sheep have lately been disposed

of at 63*s*., and even 72*s*., per head. Those from Germany, however, which consist wholly of merinos, and which at one time arrived in wretchedly bad condition—in fact, completely rotten,—have shown very little improvement; and surprise has been expressed that they can be sent here at a profit, considering that they are now worth only from 15*s*. to 18*s*. each, out of which 2*s*. 6*d*. per head must be deducted for shipping and other expenses; besides which there are frequently heavy losses at sea, which are never covered by insurance. But whilst there is no actual increase in the supply of *meat* from the Continent, any deficiency is made up by the steady receipts from Ireland. That portion of the United Kingdom is still supplying London with a description of live stock—both beasts and sheep, including lambs—which finds a ready market at fair quotations. When we consider that the old Irish breeds are now nearly extinct, and that a number of valuable animals are imported from time to time from England for breeding purposes, we may rest satisfied that the breeders in Ireland are now in a position to exercise considerable influence upon the value of meat in this country. Many of the Irish beasts lately exhibited in the great metropolitan market have sold at from 21*l*. to 25*l*., and the sheep at from 50*s*. to 63*s*. each.

Much discussion has sprung up on the subject of the difference in the present dead weights of each kind of stock, more particularly of beasts and sheep, when compared with twenty years since. Considering the great changes which have taken place in the system of producing cattle—viz. the near extinction of some breeds, and the extensive crossing in nearly all parts of the United Kingdom—this is a question of more than usual importance. In the endeavour to elucidate this matter, we cannot avoid expressing our astonishment at the wonderfully fine animals—chiefly crosses—which are now disposed of at an age at which, some years since, they would have been scarcely half-fat. We have crosses, chiefly between the Scots and short-horns, and almost wholly heifers, weighing over 100 stones of 8 lbs. We have them too in the primest possible condition, and with a full average quantity of internal and well-mixed fat. The quality of these animals is frequently superior to many of our primest Scots, and their general symmetry reflects the highest credit upon the skill and enterprise of the breeders. Notwithstanding this early maturity and the splendid weights, together with the high prices realized, there are not a few opponents to the new system; but who at the present time would keep their beasts upon the land, even for working purposes, longer than is necessary to secure a good profit? True, we frequently see large-framed and pure Sussex beasts in the London market 5, 6, and even 7 years old; but the prices

realized for them cannot possibly have compensated the graziers, even though large quantities of manure may have been obtained for the land, and even though a certain amount of capital has been saved in horse-labour. What then is the actual result as respects an increased quantity of food? On this head we have made numerous inquiries amongst the largest butchers in the metropolis, and nearly the whole of them have testified in favour of early maturity in beasts; but they do not bear the same testimony as regards sheep, which latter too frequently carry less internal fat and come lighter to the scale than formerly, taking *bulk* into consideration. In order to illustrate these remarks by actual figures, we have collected the following statistics of the *average* dead weights of the leading breeds slaughtered last year, compared with 1839:—

Comparison of Dead Weights of Beasts.

	1839. Stones (8 lbs.).	1859. Stones (8 lbs.).
Short-horns	95	100
Herefords	90	93
Devons	85	87
Long-horns	85	83
Crosses (English and Scotch)	90	98
Pure Scotch	90	90
Irish (Crosses)	80	92
Welsh Runts	87	87

Thus it will be seen that in the weight of the pure breeds very little change has taken place, the short-horns excepted, and that the increase in the supply of food is chiefly the result of crossing.

As regards the weight of the foreign beasts imported into this country since the passing of the present tariff, we may observe that, for some considerable period, it did not exceed, *on the average*, more than 60 stones: at present it has increased to 73 stones; and here we may further remark that the quality of the stock, especially from Denmark, has shown little or no improvement, compared with some fifteen or sixteen years since. The experiments, however, made in fattening foreign beasts in this country, *where successful*, have turned out some extraordinary beasts, and, had it not been for the heavy losses by disease, very large profits would have been realized by our graziers. We may give an instance of an experiment in Norfolk. An eminent grazier, residing in that county, purchased, in the early part of last year, 200 Dutch beasts in London at 13*l.* each. They were grazed upon strong land and afterwards stall-fed. After the lapse of five months, about 100 of them were again disposed of in the London market at 25*l.* each; but out of the number originally purchased nearly 50 of them died, and the remainder produced

no profit to the owner upon the original outlay. This result, in the hands of one of the best Norfolk farmers, has naturally induced great caution on the part of graziers generally in speculating in stock which are not yet well understood in this country.

We now pass to the consideration of the increase in the dead weights of the sheep disposed of in the metropolis. Here, again, early maturity has produced results, as regards number and bulk, quite as striking as in the beasts; indeed, our impression is, that they are of more importance to the breeders. Compared with 1839, the number of young fat sheep shown in the London Cattle Market in the last year has increased beyond any former period; indeed, we may safely state that, at least, two-thirds of the supplies now offering are very little more than two years old, and it is frequently very difficult to purchase a pen of full-mouthed Downs, or other sheep, on any given market-day. Here —admitting that the sheep are bulky considering their age—we come to a point of great interest to the consumers—viz., has the supply of consumable mutton kept pace with the wants of the people? We believe not. In a comparative sense, the size of the sheep has been well maintained; but fat has increased in a greater ratio than lean. The consequence is, that meat is now from 20 to 25 per cent. dearer than it was twenty years ago, and that a large portion of the produce is consumed by the tallow melters. So long as this state of things continues, so long shall we have comparatively high prices, even though increased supplies of sheep may reach us both from Ireland and the Continent. In illustration of these remarks, we may direct attention to the annexed statement of the dead weights of the sheep disposed of in the metropolis, at the present time, compared with twenty years since:—

Dead Weights of Sheep.

	1839. Stones (8 lbs.).	1860. Stones (8 lbs.).
Lincolns	11	12
Leicesters	10½	11½
South Downs	10	10
Crosses	9½	11½
Gloucesters and Gloucester Downs	11	12½
Kents	11	11¼
Scotch	6½	7
Irish	6	10

This comparison shows that the *weight* of all breeds of sheep—South Downs alone excepted—has increased to some extent; the excess is the more surprising, considering that there is now a striking difference in the age of almost every breed. In the weight of the foreign sheep there has been an increase of, at least, two stones (8 lbs. to the stone) since 1846. This must be

attributed to the extensive crossing now carried on in Holland with most of our heavy breeds, such as Kents, Leicesters, and Cotswolds, including Gloucesters and Gloucester Downs—the purchases of which, on Dutch account, for breeding purposes, still continue numerous and important. Had the German flock-masters purchased English rams, and had they shown equal spirit with the Dutch farmers, we should be receiving a much larger supply of mutton from Germany than we now are, and that, too, of superior quality. In reference to lambs and calves, scarcely any change has taken place in their respective weights; but, as regards pigs, the increase has been as remarkable as in the sheep. Early maturity has produced a quantity of pork without parallel. For some time subsequently to the Irish famine, pork was selling at unusually high quotations, owing to the great deficiency in the arrivals from Ireland; but pigs, it is well known, increase with great rapidity, and, during the past six months, the numbers killed and consumed in this country have been unusually large —larger, perhaps, than at any former period. The excess in the supplies has, naturally, had some influence upon the value of other kinds of meat, especially beef and mutton; indeed, had it not been for the enormous quantities of pork offered and disposed of in the dead markets, we should have had other descriptions of meat considerably higher in price. In the past season, however—from the low value at which pork has been disposed of—immense numbers of pigs have sold for what they would fetch, and the consequence is, that a great inroad has been made upon the total supply in the country. Though still large, it is considerably less than it was six months since, and our impression is, that pork will be dearer during the remainder of the winter months than it was last season. If our conclusions be correct, both beasts and sheep are likely to be even more profitable to the graziers and breeders than at present; indeed, everything seems to point to what may be termed high quotations. The actual increase in the weight of pigs—carrying back our comparison twenty years—cannot be less than 12 lbs. for each carcase. In that increase must be considered the fat, which, in not a few instances, has represented the total increase in the carcase.

Consumption of Meat in London.

Many opinions have, from time to time, been hazarded in reference to the actual quantity of meat consumed in the metropolis in each year; but this important question has evidently been handled by those who have had no practical acquaintance with it. Some persons have assumed that the whole of the beasts, sheep, lambs, calves, and pigs, disposed of in the Metro-

politan Cattle Market are consumed in London; whereas such is not the case. For instance, how frequently does it happen—in point of fact it is the case on almost every market day—that a portion of the stock—beasts and sheep are here referred to—is taken on speculation for grazing purposes. Most of the lean beasts are purchased for grazing in the Essex marshes; and the lean sheep are distributed in the counties of Middlesex, Surrey, Essex, Bedfordshire, and Hertfordshire, to be again brought into the market for butchers' purposes. It must be understood that London is not, so to speak, a lean stock market; but it frequently happens that flockmasters are compelled to part with their stock otherwise than in good saleable condition. This stock, then, is re-grazed, and, of course, figures *again* in the returns of the supplies brought forward. As nearly as can be ascertained, these transactions amount to about 200 beasts and 700 sheep in each week, which have to be deducted from the actual supplies returned. Again, it is a false conclusion to assume that there are no sales except for London consumption. Country buyers frequently purchase largely, and a portion of the consumption of towns within ten and even fifteen miles of London is met by the supplies disposed of in the Metropolitan market: during the month of December, especially, purchases are effected for consumption in Birmingham, Manchester, Leeds, Brighton, Bristol, and other provincial towns, which sometimes carry off many of our best kinds of beasts and sheep. Another feature well known to most of our graziers here requires to be noticed, viz., the numbers of stock *turned out unsold* during the year. Heavy supplies, coupled with a dull trade, have frequently resulted in from 100 to 200 beasts and from 1000 to 2000 sheep being unsold at the close of Monday's—sometimes on a Thursday's—market, which are again re-offered for sale in the following week. It follows, therefore, that, from the aggregate supplies offered in each week, we have to deduct rather an important portion of the supplies, which again come forward at some future period. From this deduction we must not suppose that the whole is undisposed of at the end of the year, but merely that a certain portion of the stock has been sold twice over, and that a proportionately less supply has really passed into the hands of the butchers. Even twenty years since such was the case, and, perhaps, to a greater extent than at present, because consumption was much smaller than it now is, sheep were kept longer on the land, and the supplies of stock were, if anything, larger, in proportion to the wants of the consumers, than at present. These are highly important facts to notice at this moment, because we have open ports, and yet high quotations; we have competition in stock from every available source, and

yet prices rule as high or higher than ever. Holland, Denmark, Spain, Portugal, Germany, and—last, though not least—Ireland, are competing with the English grazier, but with what success is shown by our tabular statement of prices. But how can we anticipate *low* currencies for either beasts or sheep whilst the trade and commerce of the country are in so flourishing a condition, and whilst, consequently, the consuming powers of the people are rapidly increasing?

In this age of railways and steamboats, in which great competition for freights exists, both as respects land and water-carriage, it would be a mistake to suppose that the consumption of London, with its 2,400,000 inhabitants, is solely represented by the Metropolitan, or live-stock, market. There are other influences at work, which, if not taken into account, would vitiate any estimate of the actual quantity of meat consumed in the metropolis in any given year or series of years. We refer to the dead-meat markets, which, for importance, are second to none in the kingdom. Having been furnished with statistics by those upon whom we may place reliance, we have no hesitation in laying before our readers the following figures. We find that, during the year ending June 30, 1859, the following quantities of meat were received from various distant sources of supply up to Newgate and Leadenhall markets:—

	Beef.	Mutton.	Lamb.	Veal.	Pork.
No. of carcasses	22,000	98,700	34,500	3,250	227,200

It must be understood, that in the above figures are not included the supplies sent in by the metropolitan slaughtermen, or the purchases of live stock made by the butchers residing in Newgate and Leadenhall. The quarters from whence the bulk of these receipts were derived are Scotland, Yorkshire, and the West of England, from which latter district about 90,000 carcasses of pigs, chiefly imported from Ireland alive, have been derived. Twenty years since the quantities of dead meat received from Scotland, and different parts of England, were nearly as follows:—Beef, 9,500; sheep, 70,000; lambs, 22,000; calves, 3,100; and pigs, 147,000 carcasses. It follows, therefore, that increased consumption has been steadily met by increased supplies of food.

Supplies of Live Stock exhibited in the Metropolitan Cattle Market.

Beasts.	Sheep and Lambs.	Calves.	Pigs.
259,491	1,415,551	22,456	34,310

Supplies of Scotch and Country Meat sold in Newgate and Leadenhall.

Beef. Carcasses.	Mutton and Lamb. Carcasses.	Veal. Carcasses.	Pork. Carcasses.
22,000	133,200	3,250	227,200

The above figures represent the following totals—say in carcasses:—

Beef.	Mutton and Lamb.	Veal.	Pork.
281,491	1,548,751	25,706	261,510

For country consumption, and for the stock turned out, including grazing purposes, we may deduct from these figures 18,000 beasts and 113,000 sheep; hence, it follows that 263,391 carcasses of beef, 1,435,751 of mutton and lamb, 25,706 of veal, and 261,510 of pork supplied the consumptive demand in the metropolis.

In the minor stock it will be seen that we have made no deduction—the supplies exhibited having been almost wholly taken by the London butchers. The annexed return shows the total numbers of beasts exhibited in the Metropolitan market in a series of years:—

1846.	1847.	1848.	1849.	1850.
213,507	240,195	237,143	243,760	252,137
1851.	**1852.**	**1853.**	**1854.**	**1855.**
261,684	273,519	290,239	282,639	272,945
1856.	**1857.**	**1858.**	**1859.**	
273,523	250,224	258,710	256,571	

Demand and Value during the Past Year.

Compared with several previous years, the past has proved a good season for stock from nearly all sources of supply, and prices have continued high, though not in advance of either 1858 or 1857. The Northern districts furnished 68,470 beasts, against 71,260 in 1858, and 81,600 in 1857. The number from Norfolk, Suffolk, Essex, and Cambridgeshire was a full average one; but from other parts of England the receipts were very large. The imports from abroad were about 12,000 head less than in 1854. As regards sheep, it will be seen that a larger number was brought forward last year than in any year since 1854—the total supply having amounted to 1,462,036 head, against 1,335,597 in 1858, and 1,238,204 in 1857.

Supplies of each kind of Stock Exhibited and Sold during the following Years:—

	1854.	1855.	1856.	1857.	1858.	1859.
Beasts	257,167	246,306	252,624	250,224	258,710	256,571
Cows	6,227	5,625	5,841	5,630	6,054	6,007
Sheep and Lambs	1,498,525	1,423,418	1,335,474	1,238,204	1,335,597	1,462,036
Calves	24,853	23,420	20,395	23,426	24,164	19,558
Pigs	34,280	38,940	34,077	28,232	32,646	30,999

"District" Bullock Supplies.

	1854.	1855.	1856.	1857.	1858.	1859.
Northern Districts ..	59,740	53,400	61,660	81,600	71,260	68,470
Eastern Districts	57,300	64,080	56,700	67,500	73,860	71,060
Other parts of England	33,200	24,580	34,550	29,860	28,380	42,310
Scotland	12,976	12,820	12,742	10,796	11,130	14,730
Ireland	..	..	..	..	18,580	11,761
Foreign	49,603	49,030	41,211	35,222	36,446	37,974

Average Prices of Beef and Mutton.

	1854.	1855.	1856.	1857.	1858.	1859.
BEEF:—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Inferior	3 0	3 2	2 10	2 10	2 10	3 0
Middling	4 0	4 2	3 10	3 10	3 10	4 0
Prime	5 2	5 2	5 0	5 0	5 2	5 0
MUTTON:—						
Inferior	3 2	3 2	3 0	3 2	3 0	3 2
Middling	4 0	4 2	4 0	4 2	4 0	4 2
Prime	5 0	5 2	5 2	5 4	5 2	5 2

We may conclude this report by observing that the prospects of the graziers are favourable, notwithstanding foreign competition; and, further, that our impression is that prices, under the influence of great activity in trade and commerce, are likely to rule high during the whole of the present year.

5, *Argyle Square, St. Pancras, London.*

XXVII.—*Influence of Climate on Cultivation.* By R. RUSSELL, F.R.S.E.

IN treating of the effects of climate on agricultural plants and farm-practices, there are a few special points connected with rye which are deserving of notice. As a crop, though never entering prominently into rotations, it was at one period cultivated more extensively than at present. Its habits and requirements are pretty well known to practical men, but have not received much attention from men of science. In the wide sandy plains of the north of Europe it forms the most productive bread-yielding plant, and is largely raised. But we are still very much in the dark regarding those peculiarities in its constitution which render it capable of maintaining a comparatively healthy growth, where other cereals languish and are unproductive. As sandy soils become improved in their physical texture by marl or clay, or

other practices, wheat takes the place of rye. The history of Norfolk farming bears ample testimony to this revolution in the cropping of weak sandy soils.

Chemical analysis fails to show that rye can dispense with any of those constituents which are found in the straw and grain of wheat: it rather indicates that an explanation of the requirements of the two plants will only be found in differences in their physiological structure. The whole of these differences we may not be able to trace, nor do they all come within the scope of this paper. It is only such as are connected with climatic agents with which we have to do, and which in all probability are the most influential.

It is well known that rye flourishes on dry and sandy soils, where other cereals do not thrive. This fact is best accounted for, perhaps, by supposing that rye evaporates less water during its growth than wheat. One of the chief ends of marling, claying, or vegetable manuring, is to improve the physical properties of soil which consist in retaining moisture for the plants that grow upon it. In moist climates it is found that such means of adding to the fertility of land are less required. For this reason, wheat succeeds much better after green crops on the light sands of the west coast of England and Ireland than it does in Norfolk. In the latter county, evaporation being greater, artificial means must be used for increasing the absorbent and retentive powers of the soil for moisture, in order to supply the greater demands of the wheat crop. The fact of rye requiring less moisture, at the same time that it takes up as much food as wheat from the soil, implies that the quantity absorbed is by no means in proportion to the amount of water that is transpired by the leaves. Such a principle, it appears to us, requires to be recognised in accounting for the suitability of different crops to different soils and climates.

The scientific world is at present divided on this subject. Professor Way's experiments showed that the nutrient matters of plants are fixed by soils and rendered to some extent insoluble. Some writers, however, maintain that the insolubility of the food of plants is not so absolute in its character as to prevent plants taking up in the water which evaporates through their leaves as much earthy matter as is found in their ashes. Rain-water dissolves a certain amount of earthy matters, which, it is considered, are sufficient to supply plants with all the food they derive from the soil. Experiments show that the quantity of water which plants evaporate is indeed great, and in some cases it may be amply sufficient to convey into their structure a full supply of mineral matters, although these are only very sparingly soluble. On the other hand, some believe that a special absorbing function exists in the roots of plants, whereby they

have the power of taking up food from the soil in far greater quantity than is soluble in the water which merely evaporates through their leaves. The rapidity of growth in plants, it is certain, is by no means in proportion to the amount of water that they transpire, but often the reverse. It must be borne in mind that plants grow rapidly in close greenhouses or Ward's cases, where there is comparatively little transpiration by the leaves. These instances, as Professor Johnston, Yale College, Connecticut, observes, demonstrate that there is little connection between the amount of water exhaled and the quantity of matters absorbed by vegetation.

We need not enter further upon this interesting question. Many unresolved problems in agriculture are however, as it appears to us, bound up in its full elucidation, to which it would be out of place at present to advert. It is only with that branch of the subject relating to the exact nature of the agents which influence the growth of plants under different climatic conditions that we have to do. If, however, for the sake of argument, we assume that the quantity of food taken up by plants from the soil is not in proportion to the amount of water which they evaporate from their leaves, it puts us in possession of a simple and consistent means of explaining certain habits of plants. Rye, in this view, partly derives its power of growing in loose sandy soils from its evaporating less water than other cereals. This supposition, as already observed, implies the existence of a power residing in the rootlets of plants, whereby they exercise a solvent action on those substances within the soil which constitute their food. Hence we assume that plants, whose physiological structure is otherwise similar, have the power of resisting drought in the inverse ratio to the amount of water they transpire by their leaves.

The freer growth of the rye plant than of other cereals under certain atmospheric conditions has, perhaps, much to do with its greater power of resisting the exhalation of water from its leaves. Rye is sown for feeding sheep early in the spring in the south of England, but it is almost a worthless plant for this purpose in Scotland. The temperature during the day in the south is comparatively high, which has the effect of stimulating its vegetative powers. A considerable amount of growth takes place, which, we are inclined to think, is so far to be attributed to the greater resistance that this plant offers to the exhaling influences of a dry atmosphere. It must be kept in mind that in many instances an ample supply of water in the soil does not make up for a greater demand on the plant, in consequence of increased evaporative force. Professor Piazzi Smyth tells us that certain trees do not thrive well in the dry air of Teneriffe, though they are

irrigated. The temperature is as high there as in other parts of the torrid zone where these trees flourish, but the due amount of vapour in the air is wanting. Horticulturists, too, know that abundance of water at the roots of plants, in a hot-house, is no compensation for a want of the same element in the gaseous form, which has the effect of checking that excessive transpiration through the leaves, which seems to have an exhausting effect on the vital energies of many plants. It may be observed that these facts also indicate that the growth of a plant is not in proportion to the amount of water that passes through its structure, but rather the contrary. So we may naturally expect that many plants are fitted for particular soils and climates, by the resistance which their leaves offer to the exhaling influences of the atmosphere. In the absence, however, of direct experiments on the evaporative powers of different plants, our deductions are only put forth as mere suggestions for the explanation of facts that experience has made known.

The rye plant strikingly exhibits the effects of what may be termed the climate of the seasons. Its greater power of economising or husbanding the moisture of the soil appears to impart to it certain advantages when sown in summer, for it then grows very freely. Like most other cultivated plants, too, it shows comparatively little tendency to seed when sown in the hot season, but, on the other hand, produces a great profusion of stems and leaves. Such a luxuriant growth could only be obtained in spring by a large expenditure of nitrogenous manures, which clearly shows that to a certain extent temperature acts as a compensation for manure. The common varieties and the St. John's Day rye, especially when sown about the summer solstice, even in the warmer parts of the continent of Europe, become valuable forage-plants by producing an abundance of soft succulent stems and leaves.

Flax.—A great many very curious opinions have long existed respecting the exhausting qualities of the flax crop. All the Roman agricultural writers, without exception, regarded it as one of the most exhausting crops that could be put into the ground. The same notions seem to have been entertained throughout the middle ages, and to have descended to our times, as the articles of many a lease both in Scotland and England bear witness. Chemical analysis does not assist us in arriving at any just or satisfactory conclusion on the subject. At least, analysis is only of a negative kind of aid, showing that this crop cannot rob the soil to a greater extent of its valuable constituents than others do. But we submit that the whole question is most satisfactorily cleared up by examining the facts from the same points of view as we have already done in the case of the cereals. Indeed, this

crop furnishes remarkable illustrations of its greater or less dependence on the soil for a supply of nitrogen for its growth, according to the climatic conditions under which it may be grown. If this principle be overlooked, it is in vain to think of arriving at accurate ideas respecting the relative exhausting qualities of plants.

Flax has long been cultivated by the small farmers of the northern parts of Ireland, and is extensively grown there at the present day. Arthur Young, in his 'Tour in Ireland, in 1776-7-8,' writes:—"There is a notion common in the north of Ireland, which I suppose must be very prejudicial to the quality as well as the quantity produced: it is, that rich land will not do for it, and that the soil should be pretty much exhausted by repeated crops of oats, in order to reduce it to a proper state for flax." This notion was, no doubt, very erroneous, but it is to be traced to the particular practices which were followed, and formed a part of a system not inconsistent in itself—all the other crops, chiefly oats and barley, were invariably sown late, as the land was in poor condition. Flax, when sown early on land exhausted, is exceedingly susceptible of frosts in spring, and will seldom produce other than a poor return; but, on the other hand, when sown late, temperature being to some extent an equivalent for nitrogenous manure, tolerable crops are obtained, although the land is considerably exhausted. When sown late on rich soil, the plant rushes rapidly forward, and weak straw liable to fall down is the result. Under these conditions we can readily believe that rich land is prejudicial to the growth of flax. The fact, however, of a crop, like flax, growing even moderately well on land which is in a poor or exhausted state, implies that it has great powers of relying upon the atmosphere for carbonic acid and ammonia. It is difficult to reconcile its exhausting properties with its capability of growing on land whose fertility has been reduced by several successive crops of oats or barley. So far as the soil was concerned, under the rotations pursued when Young made his tour in Ireland, there was not much in it to exhaust when it was considered fit for a crop of flax. We can only attribute the opinion of the exhausting qualities of flax to its habit of growing freely when sown during the warmer period of the year, even on poor soil, and thus using up the remains of fertility.

The practices followed in the cultivation of this plant in other countries support these views in a remarkable degree. In Belgium the finest crops of flax, in point of quantity and quality, are raised. There it receives liberal dressings of manure. Indeed, the exhausting qualities of the plant may be said to be courted, inasmuch as it may either be grown with much or little manure. The farmers have clearly recognised the principle, that an in-

crease of temperature during the early stages of the growth of the plant is, to a certain extent, a compensation for manure. The crop is sown early in the season when highly manured, and late when the land is poor. This custom is well brought out by the writer of the article 'Agriculture of Flanders,' in Morton's 'Cyclopedia of Agriculture.'

> "In the environs around Courtray the best flax in Europe is grown on the rich dry soils of that district; there they make only use of rapecakes with liquid manure. They take for the land that is not exhausted about 600 cakes per acre; these cakes are soaked in the liquid manure for ten days, to be dissolved, after which the ground is watered with the mixture. The time of sowing is very various in the different districts of Flanders, from the first week of March till the beginning of May. Near Courtray they sow first, and the farmers in the Aalst country, or on wet and heavy loam soils, are the latest. *The later the flax is sown, the less it requires manure;* as, otherwise, the flax grows too speedily, too thin, and falls down."

In the recent partial introduction of the cultivation of flax into Britain, the principles that attend its successful cultivation in Belgium are beginning to be more fully recognised. In Scotland and England, as well as in Ireland, the opinion was pretty prevalent that the crop might be raised with little or no manure. In former times, indeed, it was seldom or never manured. It is now found, however, that quantity and quality are dependent on manuring and early sowing. On the rich silt-land in the neighbourhood of Spalding, in Lincolnshire, where a considerable quantity of flax is raised, it is found that it can scarcely be sown too early if the land is in good condition. The quality of flax fibre seems to be regulated by causes similar to those which regulate the quality of the straw of the cereals. By liberal manuring and early sowing, straw becomes finer in its colour and firmer in its texture. The rapid growth which results from late sowing on rich or highly-manured land renders the fibre of flax coarse and less valuable. For this reason, flax is of poor quality when grown in hot countries—such as Egypt and India.

In Scotland experience is slightly different with respect to the culture of this crop. It is right to observe, however, that it has only been partially cultivated there, and in most cases where the climate is somewhat unpropitious as well as the soil. In these circumstances it has been found that it does not succeed so well when sown too early. The low temperature of the soil and air, when sown too early, keeps the plant too long in a semi-dormant condition, and in this state it sometimes suffers from rains and frosts. Late sowing gives a more vigorous plant, and, the summer heats being comparatively temperate, its growth is not so rapid. Indeed, flax sown in Scotland in the beginning of May almost occupies the land for as long a period as it does in Belgium when sown in the beginning

of March. If the land is also well cultivated and manured, it forms a good preparation for wheat. In former times flax was chiefly grown upon poor land and received no manure, and no doubt, under these circumstances, it was a scourging crop. Now, however, fine quality of fibre cannot be obtained unless the soil is in such high condition that a crop of wheat can be taken after it. This, to some extent, is a security that the land will not be deteriorated by the culture of the crop. In those parts of Belgium where the finest qualities of fibre are raised, wheat usually follows flax. The remains of the liberal manuring which the land receives are sufficient to produce a crop of wheat, which is generally admitted to require an abundant supply of nitrogen from the soil. But what a contrast do the rotations followed in the end of the last century in the north of Ireland present! Young tells us that, on good land, the following course of crops was not uncommon:—1, potatoes; 2, barley; 3, oats; 4, oats; 5, flax; 6, lay, 2 or 3 years; 7, oats; 8, oats. By late sowing, and by being satisfied with an inferior product, both as to quality and quantity, flax, in the hands of the Irish farmers, was made the agent of extracting from the soil the very dregs of fertility.

The relatively exhausting qualities of different crops have formed fertile themes for discussion among agricultural writers. Most of the ideas which exist, or existed, among farmers on the subject have had some grounds for their prevalence. In many cases, however, cause and effect have been confounded. With respect to the term "exhaustion," it has not been hitherto sufficiently recognised that it is often used in *two* senses, which are almost diametrically opposite. More accurate ideas on this question will be obtained by considering the effects of temperature, in giving plants greater or less power of relying upon the atmosphere for a certain supply of food.

Flax, as has been shown, when sown late in the season, requires comparatively little manure—that is, carbonic acid and ammonia; but, in such circumstances, being capable of appropriating the little that exists in the soil, it is undoubtedly an exhauster. On the other hand, flax as cultivated around Courtray takes a good deal more ammonia from the soil, and, consequently, less from the atmosphere. Hence it might be there justly considered as peculiarly exhausting, though it is not esteemed so. The fact is, it cannot exhaust or take up all the manure which is so liberally applied: what remains in the soil is sufficient to raise excellent crops of wheat, which undoubtedly proves that the land is far from being left in an exhausted state by the flax plant. In ordinary farm management, it will be found that any crop which demands a liberal supply of food in the soil usually receives as much as leaves a moderate quantity for those

which succeed it. These simple and well-known distinctions not having been clearly kept in view, some very erroneous notions have long been entertained regarding the relative exhausting qualities of the cereals.

In those districts of Great Britain, for example, where barley and oats were usually sown late, wheat was held to be a much less exhausting crop than either. The requirements, indeed, of wheat and barley stood to each other in almost the same relations as those of *early* and *late* sown flax. Wheat, as ordinarily cultivated, could not be grown without a liberal allowance of manure—so liberal, indeed, that it could not take up all the slowly decomposing manure that was applied. Thus it draws less upon the natural powers of the soil, since it fails in taking up all that was artificially put in. Though, therefore, it derives more from the ground than late sown barley, yet, being far more prodigal in its requirements, it leaves more waste behind. So, on the other hand, late sown barley and flax, being less dependent on a supply of nitrogenous matters in the soil, leave it still poorer than they found it. Hence we find that wheat is sown after the highly-manured and early sown flax around Courtray. On the other hand, in moist climates where the late sowing of barley and flax is practised, they are often sown after wheat, and become the true instruments of exhaustion—as high farming in these circumstances is less essential, or even injurious.

Whenever the climate does not present obstacles to the late sowing of the cereals, a given amount of grain can be often obtained with less expenditure of manure than where early sowing must be followed. In the early stages of agriculture it has almost invariably been found that the cultivators have fallen back upon this resource. The principle upon which the practice depends has been little recognised in theoretical agriculture. It is one, however, which gives us an insight into the nature of the effects of special manures, which are greatly dependent on atmospheric influences. Phosphates, or superphosphates, for example, when applied to late sown cereals, have an influence in promoting their growth, which they seldom possess when applied to early sown crops. This arises, as already said, in all probability from plants having greater facilities for absorbing carbonic acid and ammonia from the atmosphere during the warmer season.

In the 'Genesee Farmer,' of December, 1856, published at Rochester, New York State, Mr. Joseph Harris has attempted to controvert the doctrine of temperature being, to a certain extent, a compensation for ammonia. Nowhere, however, can this principle be better illustrated than by the peculiar practices of the American farmer. Mr. Lawes' and Dr. Gilbert's experiments have led them to the same conclusion with regard to the barley

crop. In their experiments, recorded in the eighteenth volume of this Journal, they find, "Other things being equal, the later the barley is sown the less should be the proportion of nitrogen in the manure, and the greater that of mineral constituents; otherwise the crop is liable to be too luxuriant." These experiments, therefore, we need scarcely add, indicate that the leaves of the barley have greater powers of appropriating ammonia from the atmosphere during the warmer season. The uniformity of Nature in the production of phenomena is well known, and what Mr. Lawes has found in the case of barley is exhibited under parallel circumstances by all crops, in a less or greater degree.

Mr. Harris finds that superphosphate of lime has a much greater effect on Chinese sugar-cane than on Indian corn. This substance produced a wonderful increase of growth on the cane, inasmuch as the plants on the manured plot rose to the height of ten feet, while those on the unmanured plot were not five feet high.*

In all warm climates the effect of applications of phosphates, &c., to vegetables is greater than in cool, for two reasons:—*First*, plants grown under a high temperature have greater powers of taking ammonia from the atmosphere, and thus are less dependent on a supply within the soil; and, *secondly*, the existence of rapidly growing conditions requires a more liberal supply of those fixed substances in the soil, owing to vegetation having less time to search for them. It must also be borne in mind, that annuals require a more liberal supply than perennials. In the climate of the United States the growth of all plants is more rapid than with us. And, therefore, it is found, that sulphate of lime, phosphate of lime, and wood ashes, are more favourite manures for clover, grasses, and even cereals, than in Britain. The special effects of these substances in the United States may not be entirely owing to climatic conditions; but are no doubt partly to be ascribed to their influence, and ought certainly to be estimated in endeavouring to explain the phenomena of vegetable growth.

In the manuring of flax and spring-sown cereals, therefore, it is of considerable importance to bear in mind, that phosphate of lime can sometimes be applied with advantage. Its special effect in promoting the growth of these crops will be all the more marked as the period of sowing is delayed. It has the effect of promoting early maturity, and in the case of the cereals a finer quality of grain is obtained. In cool and moist climates, particularly, phosphoric manures impart a sounder though less

* 'Transactions of the New York State Agricultural Society.'

luxuriant growth than nitrogenous manures alone, which, in such circumstances, should be somewhat sparingly used.

Mangold-wurzel.—This plant appears to stand at the head of all our green crops, with respect to its capabilities of producing food for stock. The climate of the south of England is admirably suited for growing it in perfection. There, under liberal treatment, it can be made to produce more than double the weight of roots that any of the varieties of turnips will do with the same amount of manure. For, like all other annual plants which attain to large dimensions, a quantity of manure must be applied corresponding to the amount of produce. To raise a maximum produce, therefore, the land requires to be little else than surfeited with manure.

The effects of those climatic agencies which we have already traced, in the culture of the cereals, are all still more distinctly exhibited by this plant. In the south the high temperature of summer, instead of hastening the formation of flowers and seeds, lengthens out its period of growth to that of a true biennial. It is patient under a high temperature, which imparts length of life, as well as increased vigour to take up and assimilate a large amount of food.

In Jersey and the southern counties of England, the seed is committed to the ground in April. On deeply-cultivated and highly-manured soils the plants show little tendency to flower during the summer. The whole vegetative powers of the plant are directed to the formation of leaf and bulb, until they are arrested by the colds of approaching winter. These powers, as is well known, are proportioned in a great measure to the temperature and the period over which they are extended. The produce, therefore, of mangold-wurzel in Britain is, in all probability, greatest when the mean temperature is highest. The author of a report in the last number of the Journal mentions a well-authenticated case of seventy tons to the imperial acre being produced in Jersey.

The produce of mangold diminishes in Britain as the latitude becomes higher. To grow even moderate crops a much more copious application of manure is required, the vitality of the plant being weaker in consequence of the lower temperature. This want of vigour in the cooler climate is indicated by the larger number of the plants that form flower-stalks. At an elevation of 600 feet in Scotland it is not uncommon to find nearly one-half of the plants seeding, and in the warmest parts of that country this tendency is complained of. The only counteracting influences that can be brought into play are deep culture and more than liberal manuring. For, with respect to mangold as to cereals and

other plants, a low temperature and an impoverished soil favour the production of flowers and seeds, while a high temperature and rich soil have effects exactly opposite. The increased precariousness of the turnip crop in Scotland of late years has been the means of directing more attention to the culture of mangold. These efforts have been by no means unsuccessful. Mr. Hope, of Fentonbarn, reports that, while the best fields of Swedes in the plains of the Lothians weighed from 12 to 16 tons to the acre last season (1859), some fields of mangold weighed from 24 to 38 tons to the acre. The summer was no doubt unusually dry and warm, and turnips have not been so poor a crop for many years.

Turnips.—In ordinary years the Swede turnip in Scotland supplies the place which mangold does in the south of England. In the north this root can be sown almost as early in some of the moister districts as mangold can in the south. The period of its growth is extended over the whole summer and autumn, if the soil is deep and strongly manured. Indeed, if early sowing is practised, there is little danger of too much nitrogenous manures being applied, provided always that the plants have sufficient space in which they can grow and expand. The character of the manures, as in the case of mangold, should be of such a nature that they slowly yield up nitrogen to the plants during the whole period of their growth. We need scarcely say that a perfect system of manuring plants would consist in giving a daily supply of food, and in no greater quantity than they could take up and assimilate. Under the most favourable conditions, however, the Swede cannot assimilate nearly as much food as mangold, and, consequently, it need not be so lavishly given.

Where the climate is dry and forcing, early sown Swedes are comparatively inferior as a root-crop. No amount of manuring will compensate for the unfavourable atmospheric conditions. Under such circumstances the plant does not yield a grateful return for the care and labour bestowed upon it, but by late sowing the qualities of the plants are turned to better account. When sown at Midsummer, in the south, a vigorous growth and moderate crop is obtained by dressing with superphosphate alone. Excepting on land more than ordinarily rich, Swedes are as rarely attempted to be raised with non-nitrogenous manures in the north as mangold in the south. It is only the late varieties of turnips which are much benefited by such applications; these, being shortlived, comparatively speaking, and the produce greatly smaller, do not require much nitrogenous manure.

When Swedes, or other turnips, are sown about Midsummer, the early stages of growth take place when the soil and atmos-

phere have attained their greatest heat. All plants then have greater powers of assimilating ammonia and carbonic acid directly from the atmosphere. As phosphorus and nitrogen are chemically associated in the vegetable structure, the abundant supply of the former seems to form the attraction for the latter. It is apparently for this reason that all annuals are benefited by a supply of phosphates when sown late in summer. The rapidly growing conditions that exist are greatly assisted by the presence of a fresh supply of these substances in the surface soil. It is easy to see that those plants which have the smallest seeds, and at the same time ultimately grow to the largest size individually, must be most benefited by phosphates. The small seed of the turnip, for example, does not contain as much phosphoric acid as will afford a supply for the formation of the rootlets which may run through the soil in search of other food, and, consequently, the growth of this plant is greatly assisted by dressings of phosphates. The beneficial effects, however, it ought to be borne in mind, are confined to the warm season. But even cereals which have comparatively large seeds are also benefited by the same applications when sown under similar atmospheric conditions. As might naturally be expected the sorghum or Chinese sugar-cane, whose seeds are small and sown during the warm season, has its growth amazingly increased by superphosphate of lime.

Baron Liebig informs us* that the parsnip which is raised in the sandy soil in the village of Teltow, near Berlin, rarely weighs more than 1 oz. The deficiency in the physical properties of the soil are such that the roots are not capable of exceeding this limited size. This defect in the soil causes the further expenditure of manure to be attended with comparatively little benefit. The plant can only work up a limited amount of food, whether of ammonia or phosphate. The same variety of parsnip, however, grows to several pounds in weight when sown in rich soil. In this case, the physical properties of the soil enable the plants to assimilate a full quantity of food, and thus to produce large roots. Phosphoric manures might perhaps produce as large crops of parsnips on the sandy soil as nitrogenous manures would do, but their full development on the richer soil could only be obtained by the use of the latter.

Now the same principle will serve to explain many of the discordant opinions that are held respecting the relative value of phosphoric and ammoniacal manures for the turnip crop. In the light and shallow soils of the chalks and gravels of England, the

* 'Chemistry in its Application to Agriculture and Physiology,' 2nd edition, s. 50.

four-course shift, in which the turnip follows the wheat, is almost invariably adopted. The clover-stubbles are dressed with farm-yard manure. A considerable amount of slowly decomposing vegetable matter yields up a considerable amount of nitrogen to the turnip. On the weaker soils this is, perhaps, as much as their deficient physical properties will enable the plants to work up or assimilate. The Swede, on the chalky and gravelly soils of England, is restricted in its growth in a manner similar to that of the parsnip at Teltow. No amount of any kind of manures enables the soil to produce maximum crops when such radical defects exist. Ammoniacal manures are not attended with the same results as when the plants can attain to their full growth.

Over the wolds and downs of the south of England, where the physical properties of the soil are so deficient, phosphate of lime is in many instances sufficient, or nearly so, to raise such maximum crops of Swedes as these thin and hungry soils are capable of growing. The addition of large quantities of nitrogenous manures is attended with the same waste as in giving an animal larger quantities of rich food than it can digest. On the other hand, even in the south, where the soil is of deeper staple and more retentive in its character, it is, comparatively speaking, grateful for nitrogenous manures when applied to the turnip crop. The economical application of these substances is dependent upon the plants having those conditions of soil which maintain them in health, so that they can assimilate, like the mangold, an abundant supply when placed within their reach.

As is well known, thin and weak soils are better fitted for maintaining the growth of the Swede in the moist climate on the west coast than in the drier climate of the east. There the lower temperature and less-exhausting character of the droughts maintain the plant in vigorous growth through the summer months. These conditions admit of large crops being obtained, but only by the liberal application of manures having a considerable quantity of nitrogen in their composition.

It ought to be borne in mind, too, that with turnips, as with cereals, the advantage of having the nitrogenous element combined in the vegetable form is all the more essential as the climate becomes drier. As formerly observed, this form of manure seems to have the effect of acting as a diluent of nitrogen, probably by its hygroscopic properties in attracting moisture from the atmosphere. On weak soils, therefore, physical deficiencies are so far compensated by vegetable manuring. A large amount of soluble food in a soil can only be economically taken up and turned into vegetable structure when the plants have a full supply of moisture. Irrigation allows Italian rye-grass to

expand and flourish in weak soils and assimilate prodigious quantities of nitrogen, which would otherwise be all but lost. Irrigation might no doubt cause nitrogenous manures to be held in greater repute in the sandy turnip-soils of the south; but, in the absence of such appliances, vegetable manuring is found to add to the fertility of the soil when phosphoric and ammoniacal manures have ceased in a great measure to add materially to the growth of the crop.

Accordingly, phosphoric manures are most advantageously applied to late sown crops of turnips, whose period of growth is comparatively short. Those varieties, on the other hand, which are sown earlier, or where the soil or climate tends to promote their extended healthy growth, admit of larger quantities of nitrogenous manures being applied. It is often a matter of indifference whether late-sown turnips be dressed with guano or superphosphate of lime. By the aid of a ready supply of phosphates, they find as much ammonia in the soil and atmosphere as they can assimilate, and consequently none need be added. Where the climate and state of the soil admit of early sowing, nitrogenous manures are indispensably necessary to produce full crops. Large quantities of Peruvian guano are applied to Swedes with the best results on the deep and rich loams of the Lothians. Early sowing counteracts any tendency which the plants may have to produce an undue amount of leaf. On the other hand, on light soils, where the five-course rotation is followed, in which the land lies two years in pasture, phosphoric manures are relatively more valuable; the later varieties of turnips are generally sown, and the physical properties of the soil do not admit of the largest crops being grown. In these circumstances it is found that superphosphate is as valuable a fertiliser as the best guano: this only holds, however, on dry soils. On the other hand, guano produces larger crops on undrained land or on the more retentive class of soils. In the latter cases, the soil possesses superior mechanical properties, which alone can permit the plant to arrive at the full development of its capacities of growth.

In the cultivation of the turnip-crop, in climates and soils of different natures, the same principles may be otherwise illustrated. Where the soil and climate are only suited to grow small-sized roots, the crops are sown on the flat and drilled at narrow intervals. For the same reason, the sowing of turnips broadcast is still followed in some instances, on inferior descriptions of soil, in the eastern counties. As the soil and climate become more suited to grow larger roots and larger crops the spaces assigned to the individual plants become greater. In the light soils of the south, where phosphoric manures alone are almost suf-

ficient to raise as full crops as the land will grow, a comparatively moderate space is allotted to each plant. On the other hand, in the north and west, where the soil and climate are so favourable as to enable the plants to work up a large amount of nitrogenous manures and to produce crops of 40 tons to the acre, almost as large a space is assigned to the plants of the Swede as to mangold-wurzel in the south.

The Swede turnip seems to possess greater powers of resisting the droughts of summer than the other varieties. As suggested in the case of mangold-wurzel, its more glossy and waxy leaves may prevent or moderate evaporation to some extent. The little repute in which the common yellows are held in the south is perhaps a good deal owing to their perspiring more moisture through their leaves. The purple-top yellow seems to exceed all the others in this respect, if we are to ascribe its extreme susceptibility to drought and heat to this cause. On the other hand, in moist seasons it yields an abundant produce and bears copious manurings of nitrogenous substances. The white globe variety of turnips seems to resist drought more effectually than any of the common yellow varieties. But Swedes thrive well in a moist atmosphere, in which the quantity of water transpired through the leaves must be small in comparison to that which takes place where the climate is dry.

Potato.—This plant illustrates in a very striking manner the influence of climate and cultivation on its produce. Brought from the cooler climates in the elevated regions of the Andes, it has succeeded admirably in temperate latitudes. Its leaves, however, seem as easily injured by frosts as when it was first introduced into Europe—a fact which betrays its tropical origin. In hot countries, the vegetative powers of the plant seem chiefly directed towards the formation of stems, leaves, and seeds. In higher latitudes, on the contrary, a larger portion of its juices are directed to the formation of starchy roots. Even in the northern states of America the plant has a great tendency to throw out a profusion of stems, at the expense of a diminished crop of tubers, in which the proportion of starch is somewhat scanty. In the British Islands the plant seems to reach its acmé in yielding food for man. Here, and probably more in the north than the south, the climate seems most happily constituted for its growth.

The moist and warm parts of the island have suffered most from the mysterious disease which has preyed upon the crop more or less since 1845. Heat and moisture, though not the cause of the disease, evidently lend increased virulence to its attacks. The quality and quantity of the produce in the British Islands is, however, more regulated by the character and nature of the soil

than the climate. The feeding quality of turnips and grasses is greatly regulated by the inherent chemical nature of the soil, which apparently cannot be imitated artificially. Turnips, grasses, potatoes, grown on the black sands of Norfolk are all alike of poor quality. On the other hand, the red loams of Dunbar, in East Lothian, produce the finest potatoes that reach the London market: this is not owing to climate. It is the chemical qualities of these soils that impart a high feeding value to all kinds of roots and grasses that grow upon them. There are no marked differences in the mode of cultivating or manuring this crop in the British Islands, if we except the garden-like culture which is expended upon it in the south and western parts of England where early spring crops are raised.

Leguminous Crops.—The increasing relative value of turnips and potatoes, and the fact of their being well adapted for preparing the soil for cereals, has had the effect of diminishing the extent of land under beans or peas. In Scotland, before the introduction of turnips, the pea was largely sown on the lighter descriptions of soil and the bean on the richest lands. The latter requires a soil possessing retentive qualities for manure and moisture: it is injured by droughts of long continuance, and then becomes liable to the attacks of insects. For this reason it is a somewhat precarious crop in the south of England. Winter beans are less liable to be injured by drought, and grow more healthily. On the rich level plains of the Lothians the bean grows in great perfection. Its culture is usually much the same as that for potatoes or turnips: the ridges or drills are 27 inches apart, which admit of the crop being horse-hoed and otherwise thoroughly cultivated during its early growth. The English system of sowing in narrow drills of 18 inches has been recently tried in the Lothians and other parts with satisfactory results. Whether the advantages will hold in moist seasons, experiments still have to decide. The pea, on the other hand, can thrive in comparatively light soils, which seems to indicate that it evaporates less water than the bean, for it thrives in drier climates. The bean is no doubt susceptible of moisture during the blooming season, and then the flowers do not set well; but the pea is still more so, and in such circumstances the perennial qualities are so much excited that it puts forth leaves until the frosts of winter check its growth. In moderately dry climates, where the summer heats are not too great, some varieties of peas throw out fresh leaves, blossoms, and fruit, for an extended period. These afford a good illustration of the principle that the latest varieties are the most productive. When the soil has been somewhat reduced in fertility, the early varieties of peas do not bear well; but under the same circumstances the late

varieties yield more abundantly, from the fact of the succession of fresh and vital leaves continuing to absorb food from the atmosphere. Early varieties of peas must be more liberally manured, as a compensation for the shorter period of their growth.

We have thus endeavoured to give a rough outline of the general influence of climate on the most important of our agricultural crops, as well as of the different practices to which they lead. The subject has been, as far as possible, divested of its strictly technical or scientific treatment. Many interesting problems are yet to be solved in this branch of agricultural science. We shall conclude by a recapitulation of the climatic influences, which, in different degrees of intensity, seem to be common to all plants.

1. The leaves of plants seem to have greater powers of absorbing carbonic acid and ammonia from the atmosphere during the warmest season.

2. Plants absorbing more atmospheric food during the warm season require, therefore, less manure in the soil to assimilate a given amount of produce.

3. Heat and moisture thus become so far a compensation for manures yielding carbonic acid and ammonia.

4. But, as heat imparts greater vitality to plants, it enables them not only to take more of food from the atmosphere, but to work up a larger quantity applied to their roots.

5. A high temperature, accompanied by a moist atmosphere and an abundance of manure yielding ammonia, retard the flowering of most cultivated plants.

6. On the other hand, a dry atmosphere and soil, a low temperature, and a deficient supply of food within the soil, all tend to hasten the flowering and seeding of plants.

In dry soils and climates manures containing nitrogen are rendered more potent in their effects when applied in the form of vegetable matter. Like a moist atmosphere, the vegetable matrix, to a certain extent, compensates for physical deficiencies of soil.

XXVIII.—*On the Kohl-Rabi.* By PETER LAWSON and SON, Edinburgh.

DEAR SIR, Edinburgh, 14th Jan., 1860.

In sending you the following paper on the Kohl-Rabi, we think it right to state, that our own experience of it is confined to the cultivation of the different varieties, and to the growth and management of the crop on the ground. As you expressed a desire, however, for information on other points, we have taken some pains to procure it from trustworthy sources, all of which are specially indicated when they have been made use of.

As the plant is cultivated to a much greater extent in Ireland than in either England or Scotland, and with very satisfactory results, we deemed it advisable to pursue our inquiries there as well as in this country. In Mr. Corrigan, the Curator of the Royal Dublin Society's Agricultural Museum, we found a willing coadjutor. Through him we addressed a series of queries to the principal growers in that country, with a view to elicit information more especially on those points where we had no experience to guide us; and it is gratifying to record the readiness with which it was given.

There is no doubt that the culture of the Kohl-Rabi is greatly extending, judging from the increased amount of seed imported and sold in this country in the last as compared with former years. Dating from 1856, the consumption has increased fourfold; and for the present season will no doubt be large, owing to the great deficiency of the turnip crop last year, and the disposition to serious diseases which it continues to show.

Kohl-Rabi has been pronounced "the bulb of dry summers," heat and drought not being inimical to its growth, and yielding an excellent crop where white turnips and swedes could barely exist. The great mass of evidence in its favour brought forward in the following paper is crowned by the report of Dr. Anderson, whose analysis of its feeding properties proves it to be *about twice as valuable as ordinary turnips, and naturally to surpass the best swedes.*

Careful comparative experiments, on the large scale, are still wanting; and we shall be glad to hear of such experiments being instituted by some of the leading agriculturists connected with the Society, and the results published in the *Journal* for the guidance of the members.

We are, dear Sir,
very faithfully yours,
PETER LAWSON and SON.

To H. S. Thompson, Esq., M.P., Kirby Hall, York.

IN 1836, we published a description of the Kohl-Rabi in our 'Agriculturist's Manual,'* since which time, with the exception of a short notice by Mr. Towers, in the 11th vol. of this *Journal*, and the Art. "Kohl-Rabi" in Morton's 'Cyclopædia of Agriculture,' by the same writer, nothing has appeared—beyond occasional paragraphs in the agricultural papers—tending to afford additional information on the history, uses, and cultivation of this valuable plant. The Kohl-Rabi is the only crop of importance which lacks a place in our agricultural literature. No systematic account of it has ever been printed. It is not matter of surprise therefore to find that few farmers are acquainted even with its name, fewer still with its habit and appearance, whilst very few indeed know anything of its properties and value as a feeding plant. In the following paper, therefore, we purpose giving a

* Edinburgh: W. Blackwood and Sons.

history of the plant; a description of the different varieties; the best known method of cultivation and management; its average produce; the most profitable mode of consuming it; the insects and diseases which attack it; concluding with an epitome of the existing evidence as to its properties and value as a feeding plant, and as a substitute for swedes and common turnips.

History.

Some confusion seems to have existed among the older writers as to this plant, it being not very clear whether, in speaking of the *Rapo-caulis* and *Caulo-rapum*, the Kohl-Rabi or the Swedish turnip is meant. Parkinson, in his 'Paradisus' (1629), mentions the *Rapo-caulis*; but old Gerarde, in 1597, describing the various species of cabbage, clearly indicates the Kohl-Rabi. He says:—

"Of Rape-Cole the first kinde hath one single long root, garnished with many threddy strings, from which riseth up a great thicke stalke, bigger than a great cucumber or great turnep: at the top whereof shooteth forth great broad leaves, like unto those of cabbage-cole. The floures grow at the top on slender stalkes, compact of foure small yellow floures; which being past, the seed followeth inclosed in little long cods, like the seed of mustard. . . . . They grow in Italy, Spaine, and some places of Germanie, from whence I have received seedes for my garden, as also from an honest and curious friend of mine, called master Goodman, at the Minories, neere London. . . . . They floure and flourish when the other coleworts doe, whereof no doubt they are kinds, and must be carefully set and sowne, as musk melons and cucumbers are. . . . They are called in Latine *Caulo-rapum* and *Rapo-caulis*, bearing for their stalkes, as it were, rapes and turneps, participating of two plants, the coleworte and the turnep, from whereof they took their names. . . . . . There is nothing set downe of the faculties of these plants, but are accounted for daintie meate, contending with the cabbage-cole in goodnesse and pleasant taste."

In the 'Catalogue of the Plants in the Physic Garden at Edinburgh,'* published in 1683, we find the following entry:—"Brassica gongylodes, *B. P. Hist. Oxon.*; B. caulo-rapa, *I. B.*; Caulo-rapum rotundum, *Ger.*; Rapo-caulis, *Park. Parad.*; Cole-rape, *Ann.*" From this we learn that the Kohl-Rabi was an inmate of the Edinburgh old Physic Garden nearly two hundred years ago. In 1734, or just one hundred and twenty-five years since, the Kohl-Rabi was first brought into notice in field culture by Mr. Wynne Baker, the Secretary of the Dublin Agricultural Society; and, as will by and by be noticed, our Irish friends seem never to have lost sight of it, and are at the present day offering premiums for its cultivation. In 1774, the seed of the purple "Kohl-Rabi, or Red Turnip Cabbage," was advertised for

* "By Mr. James Sutherland, Intendant of the said Garden; and sold by Mr. Henry Ferguson, seed-merchant, at the head of Blackfriars Wynde."

sale in the 'Morning Chronicle' newspaper, and "to be had at Grigg's Coffee House, in Covent Garden." Thirty years later (in 1805), we find Mr. Thomas Gibbs, seedsman, in London, offering for sale "twenty-five cwt. of the seed of the Kohl-Rabi." From this circumstance we infer, that the plant at that time must have been cultivated to some extent: if not, it is probable —although we merely hazard the conjecture—that the Board of Agriculture may have offered a premium for the growth of the seed, or of the root itself. From the date of this advertisement to the publication of our 'Agriculturist's Manual,' in 1836, very little attention appears to have been given to the cultivation of the Kohl-Rabi, and, with rare exceptions, we find no mention of it in the catalogues of seedsmen.

In 1837, according to Mr. Towers, the attention of the English farmer was first systematically directed to its culture as a field crop. In that year the turnip crop suffered so severely from the ravages of the caterpillar (the larva of the moth *Ægrostis*?), that a substitute for it was eagerly looked for. Mr. Towers describes the plants of Kohl-Rabi, then raised from German seed, as having the so-called bulbs supported "by a six-inch pedestal stem, which was so stout and fibrous as to defy the grub." A couple of years appears to have been sufficient to allay the panic caused by the caterpillars; for, in 1839, according to the same authority, the culture of turnips was resumed and carried on more extensively than ever, and Kohl-Rabi as a field crop seems, for the time, to have been abandoned. It must be borne in mind, however, that Mr. Towers' experience is confined to within the range of Croydon, where his farm was situated.

In 1847, Mr. Hewitt Davis drew attention to the importance of the plant as a substitute for the turnip,* stating that he had been very successful for some years in raising heavy crops upon poor soils; contrasting, at the same time, its great value in comparison with Swedes and common turnips, "which had failed greatly that year in the south of England, from long-continued drought."

The culture of Kohl-Rabi has since been rapidly extending, both in England and Ireland, especially in the latter country: its growth having been fostered and encouraged by the premiums offered by the Royal Dublin Society. In Scotland its culture is at present very limited, from a belief that the climate is too severe. This prejudice it is difficult to overcome; but our experience enables us to state, that the Kohl-Rabi is hardier than the Swede, and that, even with the thermometer 10° below the freezing point, it is quite unaffected by frost.

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* 'Farming Essays,' p. 70.

Botanical Description.

The Kohl-Rabi belongs to the natural order Cruciferæ of Jussieu; class Tetradynamia Siliquosa of Linnæus; Cistal Alliance, order Brassicaceæ, of Lindley. Petals four, and placed opposite each other at right angles or cruciate (as in all the genera belonging to this tribe); cotyledons two, folded together, enwrapping the radicula or embryo roots; siliqua or pod nearly cylindrical, with valves opening lengthwise, and having a linear dissepiment or internal partition; seeds globular; style small, short, and blunt; calyx closed or pressing upon the base of the petals; root hardish and very slightly tapering; stem, towards its upper extremity, swollen out into a large globular, pulpy mass,* in consistence and texture somewhat resembling a Swedish turnip, from and near the summit of which the leaves—which are smooth, of various shapes and shades of colour—proceed; flowers in May and June; biennial. Native of Germany (?)

Synonyms.

Kohl-Rabi: the *Brassica oleracea gongylodes* of Linnæus; the *B. caulo Rapa* of Caspar Bauhin, the latter name being adopted by De Candolle, and now generally used; the *Chou rave* of the French; the *Cavolo rapa* of the Italians; and the *Kohl-Rabi über der Erde* of the Germans. Introduced into England by Sir Thomas Tyrwhitt, under the latter designation, it has retained it in spite of the numerous attempts to substitute other names,—such as turnip-stemmed cabbage, cape cabbage, knol-kohl, bulb-stalked cabbage, red turnip-cabbage; and even so late as 1851, we find it entered in the catalogue of Messrs. Thomas Gibbs and Co., as the "Hungarian turnip." It is also very often confounded with the Turnip-Rooted Cabbage,† a name properly belonging to a plant of quite a distinct species, viz., the *Brassica Napo Brassica*, in which class are comprised all the Swedish turnips.

Varieties.

Old Gerarde gives a drawing of the variety described by him, and we cannot resist the opportunity of transferring it to the

* This, however, is challenged by some botanists, who consider that the bulb is formed by the enlargement of the foot-stalks of the leaves. A vertical section of the bulb will show that it is the stem which is enlarged and swollen; the foot-stalks of the leaves being attached in the ordinary way to the epidermis, and having their origin in the vascular tissue of the bulb.

† The Turnip-rooted Cabbage is grown to some extent on the Continent; but is being gradually superseded by the Swedish turnip. Its properties are its hardiness; the roots growing under, or almost under, the surface of the ground, which enables it to resist the severest winters. Several varieties have been grown by us, but they differ little from the white, or, as it is emphatically termed, the Very Bad Swedish Turnip.

pages of this *Journal.* It approaches, in so far as the "six-inch pedestal stem" is concerned, the plants grown by Mr. Towers in 1837. Our cut (see fig. 1) is copied from the edition of

Fig. 1.

'Gerarde's Herbal,' published in 1633. The accuracy of the drawings in this work being unquestioned, a comparison of the plant figured therein with those in the pages following, will show what cultivation has done in developing the valuable portions of the Kohl-Rabi. The bulbs figured by us are from specimens

grown in our Experimental Grounds near Edinburgh. They are all what may be called "well-grown" plants, having little tendency to grow a woody pedestal stem, the bulb commencing generally about two inches or less above the ground.

We have eleven varieties in our experimental grounds, nine of which are adapted for field crops.

1. *Early Green or White Kohl-Rabi* (see fig. 2). (*Syn.*, Chou

Fig. 2.—Early green Kohl-Rabi.

rave blanc hatif, *Fr.;* Khol-Rabi mittelfrüher grosser feiner weisser glass, *Ger.;* Cavolo rapa blanco, *Ital.*).—This variety is best adapted for the earliest sowings, when it is desired to have two successive crops. It does not grow to so large a size as No. 3, but sets earlier even when sown at the same time. The bulb *

* The word *bulb* is used throughout this paper (although erroneously in a botanical sense) as the most concise and expressive mode of distinguishing the abnormal fleshy development of the root-stem. A better word would be *ball;* but as the former is generally used and understood, we have no hesitation in adopting it.

tapers towards the root, and weighs on an average from 4 to 6 lbs. The leaves are usually more abundant than in the other varieties; although this is not a permanent characteristic, but depends, in some degree, on the nature of the soil and manure.

2. *Early Purple Kohl-Rabi.*—This differs from No. 1 only in the dark-red or purple colour of the bulb, the foot-stalks and nerves of the leaves being tinged with the same colour.

3. *Late Green or White Kohl-Rabi* (fig. 3). (*Syn.*, Kohl-Rabi

Fig. 3.—Late green Kohl-Rabi.

grosser weisser später zarter, *Ger.*)—This variety is of a paler green than No. 1; while the leaves are larger, but not so numerous. The bulb, which is nearly globular, attains a large size, specimens having been exhibited by us at the last Smithfield Club Show, weighing $17\frac{1}{2}$ lbs.

4. *Late Purple Kohl-Rabi.* (*Syn.* Chou rave violet, *Fr.;* Kohl-Rabi später grosser feiner blauer, *Ger.*)—This variety

differs from No. 3 merely in the colour of the bulbs, foot-stalks and veins of the leaves, as in No. 2.

5. *Oblong Green Kohl-Rabi* (fig. 4).—This variety, as well as

Fig. 4.—Oblong green Kohl-Rabi.

No. 6, differs from Nos. 3 and 4 chiefly in the form of the bulb, which is oblong. The leaves in both this and the following variety, when the bulb is full grown, are nearly all on the top of the bulb, and are supported by very slender foot-stalks.

6. *Oblong Purple Kohl-Rabi.*—See description of No. 5.

Differs otherwise merely in the colour of the bulb, foot-stalks, and veins of the leaves.

7. *The Giant Kohl-Rabi.*—This is a green globular variety lately introduced from Germany. Bulbs have been raised weighing, it is said, from 20 to 25 lbs.; but, having had no experience of its growth, we cannot, until the result of our own experiments are known, venture to say anything concerning its characteristics. If all that is said of its productiveness be true, it will prove a most valuable variety.

The four following kinds have hitherto been confined to the garden. We are, however, of opinion that Nos. 8 and 9 are fitted for field culture, as we have raised bulbs, weighing from 7 lbs. to 9 lbs., of both varieties.

8. *Artichoke-leaved Kohl-Rabi* (Fig. 5).—(*Syn.*, Cut-leaved

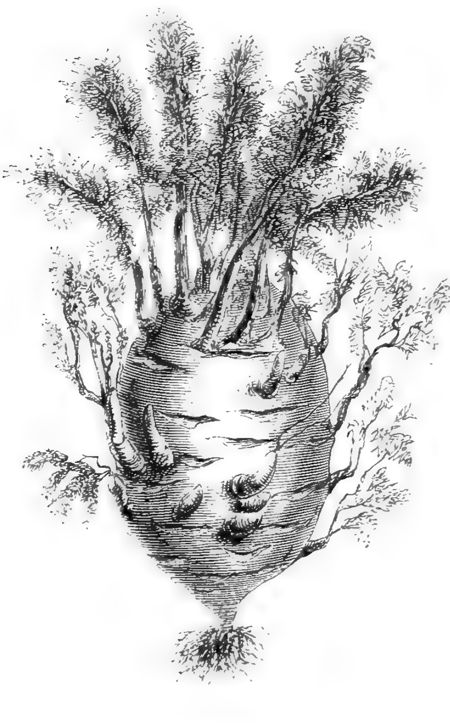

Fig. 5.—Artichoke-leaved Kohl-Rabi.

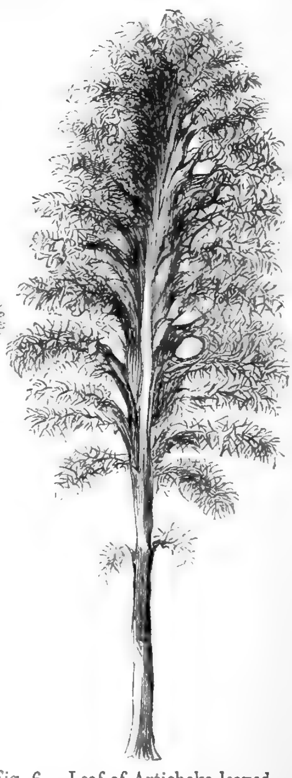

Fig. 6.—Leaf of Artichoke-leaved Kohl-Rabi.

Kohl-Rabi; Ragged Jack Kohl-Rabi; Chou rave à feuille d'Artichaut, *Fr.;* Artischoken blattriger, *Ger.*)—This is a very

distinct variety. The bulb is a pale green, irregularly shaped, inclining more to the oblong than the round, and the skin is coarser than in any other kind. The leaves (fig. 6) bear a resemblance to those of the artichoke: hence its name. The foliage is highly ornamental when growing, but the variety has no particular quality to recommend it, in preference to others, for either field or garden culture. It is supposed to be specially adapted for poor and hungry soils; but experiments are required to confirm this. This variety, in external form, approaches nearest to that figured in Gerarde's 'Herbal' (fig. 1).

9. *Neapolitan Curled-leaved Kohl-Rabi.*—This is also a very distinct variety. The foliage (fig. 7) resembles that of the curled

Fig. 7.—Leaf of Neapolitan curled-leaved Kohl-Rabi.

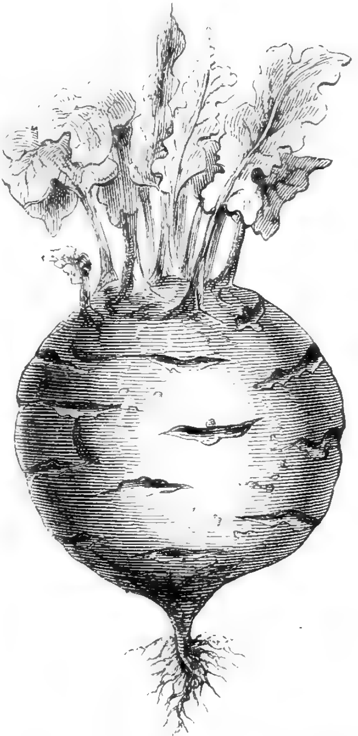

Fig. 8.—Early white Vienna Kohl-Rabi.*

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* Fig. 8, by a mistake of the engraver, has been drawn, as compared with the others, much too large. Its size, in relation to No. 3, for instance, should be one-half less.

borecole, or German greens. The bulb, which is green, is irregularly shaped, and partakes generally of the characteristics of No. 8. The leaves of this variety are not affected by the most intense frost.

10. *Early White Kohl-Rabi of Vienna* (Fig. 8).—(*Syn.*, Chou rave blanc très hâtif de Vienne, *Fr.;* Kohl-Rabi ganz früher weisser feiner Wiener, *Ger.*)—This is the smallest of all the varieties. The bulb is perfectly globular, and of a delicate glaucous green; the leaves are small, and nearly all at the top of the bulb; the foot-stalks being very slender, and spreading where they are attached to the bulb. The flesh is white, very tender and succulent. They should be used for the table before the bulb exceeds 3½ inches in diameter; for when suffered to grow larger the delicate flavour and tenderness of the flesh is lost. This variety is the most esteemed for culinary purposes.

11.—*Early Purple Kohl-Rabi of Vienna.*—(*Syn.*, Chou rave violet tres hâtif de Vienne, *Fr.;* Kohl-Rabi ganz früher feiner blauer Wiener, *Ger.*)—This variety differs from No. 10 merely in the colour of the bulb, foot-stalks, and veins of the leaves. The flavour is said to be not so delicate, but we have found no difference.

In regard to these varieties, Nos. 5 and 6 are not generally considered distinct from Nos. 3 and 4, the difference in the form of the bulb not being permanent. From the evidence we at present possess, we must look upon the oblong varieties as sports merely of the round; and what tends to confirm this is, that seed saved from both these so-called varieties produce, under special circumstances, round as well as oblong bulbs. What are the exact causes which influence the variation in the shape of the bulbs remain for vegetable physiologists to determine. The purple varieties form the bulb earlier than the green, but both kinds arrive at maturity at the same time. Generally speaking, the globe varieties are best adapted for early crops, and the oblong, both green and purple, for the late or principal crops.

The leaves of the green and purple varieties (figs. 9 and 10) differ somewhat in form and habit as well as colour. The purple kind (fig. 10) has a more upright habit, and in its outline approaches the halbert shape.

The Soil and its Preparation.

Although the Kohl-Rabi may be raised on any good turnip soil, the stronger and heavier lands—even those approaching the condition of very stiff clays—are found most suitable for its growth. Where turnips will not thrive, therefore, the Kohl-Rabi

Fig. 9.—Leaf of Common green varieties.

Fig. 10.—Leaf of purple varieties.

may be grown to the greatest advantage. In the preparation of the soil the same course may be followed as for the turnip-crop.

Manuring.

Kohl-Rabi requires heavy manuring: not less than 25 tons of farmyard manure, with 6 cwt. of good superphosphate, and 2 cwt. of common salt, should be used. Where, however, it can be obtained, 4 cwt. of Phospho-Peruvian guano may, with advantage, be substituted for the superphosphate, as it contains, in addition to a large amount of soluble phosphates, sufficient ammonia to give the plants a fair start. It is a good plan to mix this guano thoroughly with an equal weight of sand or fine ashes, so as to insure its equal distribution in the soil. "When guano alone is

employed as a manure, experiment has shown that, if it be sown broadcast over drills of the ordinary depth, and these split in the usual way, the crop maintains a steadier and more prolonged growth, and produces a better yield than when the drills are very shallow, and the manure near the surface." *

Sowing and Quantity of Seed.

The ordinary system of drilling has never been followed to any extent with Kohl-Rabi. The comparatively high price of the seed has, we suppose, led to the almost universal practice of sowing in a seed-bed at the side of the field, and afterwards transplanting to the drills. The present price of the best seed † is 4*s.* 6*d.* per lb.; and if drilling be adopted, 4 lbs. of seed per acre will be necessary, which will cost no less than 18*s.* A turnip-seed two-furrowed drill, drawn by one horse, will get over five acres a day, the cost of which may be set down at 5*s.*, or 1*s.* per acre. Singling the plants afterwards will cost 3*s.* 6*d.* per acre. In all 22*s.* 6*d.* per acre. If the young plants are raised in a seed-bed, and afterwards transplanted, the cost will stand thus: labour in preparing the bed, 1*s.*; 8 ozs. of seed, which will be sufficient to furnish plants for one acre, 2*s.* 4*d.* Four women will easily dibble an acre of plants in a day, and their wages, at 10*d.* each, will amount to 3*s.* 4*d.*, making the total cost only 6*s.* 8*d.* per acre. In a conversation we had a short time since with Professor Wilson, of the Edinburgh University, he states that, notwithstanding the additional cost, his practice has always been to sow with the turnip-drill, as he found that the uncertainty of procuring labour, added to the inconvenience of transplanting from a seed-bed, and the risk of the operation being performed in a dry season, more than counterbalanced the additional price of the seed.

In correspondence with several growers in Ireland, where the breadth of the crop is greatly extending, we find that the practice of dibbling the seed, in the same manner as that of mangold-wurtzel, is gaining ground. Mr. James Alexander, steward to the Marquis of Kildare, who has grown Kohl-Rabi for the last thirty years, says:—"I have sown Kohl-Rabi, in drills at once, about the beginning of May, by dibbling in the seed 1 inch deep, and 16 inches apart, and, when the plants were strong enough, to single them out to one in each hole, to remain for the crop. They answer very well to be sown in this way, and are not liable to be attacked by the turnip fly, as I have had them

* Morton's 'Cyclopædia of Agriculture.' Art. "Turnip," vol. ii. p. 1025.

† Mr. Innes, factor to Colonel North, found, after repeated experiments, that seed two years old produced much larger and handsomer bulbs than new seed.

growing in the immediate neighbourhood of turnips which were cut off by the fly, and the Kohl-Rabi not touched." The operation of seed-dibbling can be performed by hand at a cost of 1*s.* 8*d.* per acre—that is, two women at 10*d.* each. A horse dibble will sow four or five acres per day; but the use of this machine will rather enhance the cost of dibbling by from 6*d.* to 1*s.* per acre. Dibbling will require about 2 lbs. of seed per acre. Another grower in Ireland—Mr. William Boyle, of the Model Farm, Glasnevin, near Dublin—writes, saying that he sowed the seed of Kohl-Rabi for three years in the same manner as his swedes, and afterwards thinned them out; but enlarged experience led him to infer that a better plan was to sow the seed about the end of March in a good seed-bed prepared for the purpose, and transplant them about the time of sowing swedes. Other growers—among whom may be mentioned the Earl of Essex, Mr. Innes, factor for Colonel North, Mr. Towers, and Mr. Hewitt Davis—prefer the system of sowing in a seed-bed and afterwards transplanting; and this mode, therefore, agreeing as it does with our own experience, leads us to recommend it for general practice, both on the score of economy and the greater certainty of securing a good crop.

The following shows the relative cost per acre of the three modes:—

1. *In a Seed-bed and Transplanting.*

	s.	*d.*
Labour in preparing the seed-bed	1	0
Seed	2	4
Transplanting to the drills	3	4
	6	8

2. *Drilling with the Machine.*

	£	*s.*	*d.*
Seed	0	18	0
Drilling the seed	0	1	0
Singling	0	3	6
	£1	2	6

3. *Dibbling by Hand.*

	s.	*d.*
Seed	9	0
Labour	1	8
Singling	5	0
	15	8

The substitution of the dibbling-machine will, as previously stated, effect no saving, but, if anything, enhance the cost of the operation.

Preparation of the Seed-bed and Time of Sowing.

From what we have stated in the foregoing section, and from the prevailing practice, it is not very probable—at all events so long as the price of the seed is high and the cost of labour comparatively low—that the ordinary cultivation by the drill will be followed. We proceed, therefore, to the consideration of the seed-bed. For the convenience of transplanting it is desirable to have the seed-bed, if possible, in a well-sheltered spot by the side of the field where the crop is ultimately to be grown. A bed of 6 yards square is necessary to furnish sufficient plants for an acre. It should be well dug and manured in the winter, and finally prepared for the seed by the first week of March. If the weather be at all favourable, the seed should now be sown; but under no circumstances should this be delayed beyond the 25th of the month for the main crop. A few days are, however, of no consequence, compared with the condition of the soil—which should be in very fine tilth—and the weather favourable. If no rain falls, within a reasonable period after the seed is sown, it will be very desirable to water the beds from time to time so as to insure a favourable growth. It is best to sow in drills, about a foot apart, so as to allow of the operation of the hoe to keep the bed clean and free of weeds; for, if this be neglected, strong and healthy plants can never be secured, which renders weeding difficult and expensive. Nor should the slovenly method of sowing broadcast be followed; for as the plants are not removed to the drills until they are at least 6 inches high, they may be choked with weeds ere they attain this size, if not kept clean. By the first week of May the plants will, under ordinary circumstances, have attained to a height of from 6 to 8 inches, when they are in a fit state for transplanting to the drills. The best width for the drills is 27 inches, and they may be dibbled in about 16 or 18 inches apart. Mr. Hewitt Davis's practice is to set the plants at 3 feet apart, and a month afterwards to dibble in a second sowing between, thus reducing the distance to 18 inches between each plant. This is a plan we cannot recommend for adoption; for as the second set of plants will not attain the weight of those transplanted in May, the crop will be irregular and ready for use at different times. We are of opinion that where a successional crop is required, the second set of plants should be dibbled in drills by themselves and at a less distance apart, so that the largest number of plants may be grown on a given plot of ground. The seed should be sown at intervals for successional crops, so that the plants may not be too far advanced for the later transplantings. The first sowing should be made early in March; the second during the first or

second week in April; and a third the first week of June. These sowings may be transplanted respectively: the first in May, at 18 inches apart; the second in June, at 16 inches; and the third at the end of July or beginning of August, at from 12 to 14 inches, according to soil and climate. It will, of course, be understood that moist weather must be chosen for performing the operation of transplanting; for if done in dry weather, and no rain falls for several days after, flagging will take place and the bulk of the crop suffer. Blanks may, however, be filled up from the seed-bed where plants entirely fail; and to provide for this contingency a moderate number should always be kept in reserve. If not wanted for this purpose, they will be useful for filling up blanks in the swedes or turnips. For this purpose seed may be sown at intervals even to the end of June; and we find that this is the practice in many parts of Ireland. All things being favourable at the time of transplanting and the plants rooting well, the farmer may calculate *with certainty* on his crop.

In a letter we have received from Mr. William Kelly, land-steward, Portrane, he states that he has sown the seed in August and transplanted to the drills in March following, the same as drumhead cabbage. He adds, "I have done this once and it answered well." Although we are not disposed to recommend this plan, we should like to hear of further experiments in this direction.

Cultivation by Drilling the Seed.

We have little experience in the growing of Kohl-Rabi by this method; but if, after what we have already stated, any grower should wish to make an experiment, the ordinary system of turnip husbandry may be followed. Mr. Innes, the factor of Colonel North, of Wroxton Abbey, who has for many years paid attention to the growth of the Kohl-Rabi, informs us that he has sown it at the same time as swedes, but, not being satisfied with the result, has returned to the system of transplanting. He says that the tops of those drilled were larger, but the bulbs not so fine as those which were transplanted. This, however, as he very naturally supposes, may have arisen from the seed being sown too late. As previously noted, the evidence of Mr. Boyle of the model farm at Glasnevin is to the same effect. The only observation we have to make, in the event of drilling, is, to take care that the operation of hoeing is not performed in wet weather, for a check would be given to the growth of the plants that they never would recover. In hoeing, it is a good practice to leave the rows in tufts with a few plants in each, clearing away a foot square between them, not

forgetting to push all weeds away from the tufts. A week or ten days afterwards, the rows may again be gone over, and the tufts singled by hand, taking care to leave the strongest plant. The expense of performing the operation in this way is greater, but it is the most economical method in the end.

Management of the Crop.

While growing, the land should be kept very clean and free from weeds; and, to insure this, the horse-hoe should be in continual requisition. The plants arrive at maturity in about twenty-five weeks, when they may be pulled or stored like other root crops.

Storing.

Although the Kohl-Rabi is capable of withstanding the most intense frost, it is desirable to have it stored for winter use. Topping, in the usual mode of preparing swedes for storing, may be followed. The tailing process may, however, be omitted with advantage.

Weight of Produce.

In our own experience, a crop of 25 tons per acre is a very fair average. In stating this weight it should be borne in mind that the observation applies to the neighbourhood of Edinburgh. Further south it is within our knowledge that from 30 to 35 tons have been grown, of the oblong green variety (No. 5). Last year Mr. Innes, factor to Colonel North, gave us the following result of the produce of his crop; and, although the great abundance of leaves in the green (late) variety gives the greatest gross weight, he prefers the early purple for feeding purposes, the weight of the bulbs being nearly $2\frac{3}{4}$ tons per acre in excess of the green:—

	tons.	cwt.	qrs.	lbs.
Early Purple Kohl-Rabi bulbs	25	15	3	6
" " leaves	1	11	1	20
	27	7	0	26
Late Green " bulbs	23	1	1	20
" " leaves	8	15	2	24
	31	17	0	16

Mr. Andrew Corrigan, Curator of the Agricultural Museum of the Royal Dublin Society (who obligingly undertook for us the circulation of a set of queries with the view of eliciting information as to the cultivation of Kohl-Rabi in Ireland), has favoured

us with information relative to the weight per acre, as well as other particulars of the mode of cultivation supplied to the Committee of Agriculture, and affixed to the Prize List of the Royal Dublin Society from the year 1850 to the present date. From the particulars placed at our disposal we make the following selection:—

1850.—*Grown by the Right Hon. W. F. Tighe, Inistioge, Kilkenny.*

Soil, clay; subsoil, clay-slate; preceding crop, oats; method of cultivation, land subsoiled 18 inches deep, sown in drills 32 inches apart; quantity and quality of manure, 40 loads of farmyard-manure and 2 cwt. of guano; time of sowing, 15th of April, 1850; produce per Irish acre, 25 tons.

1851.—*Grown by the Earl of Charlemont, Marino, Clontarf.*

Soil and subsoil, deep loam, yellow clay; preceding crop, grass; method of cultivation, drills; quantity and quality of manure, 35 tons of farmyard; time of sowing, 2nd of April; produce per Irish acre, 30 tons.

1853.—*Grown by Alexander Tate, Esq., Castleknock, Dublin.*

Soil, clayey-loam; subsoil, yellow clay; preceding crop, wheat; method of cultivation, drills, 2 feet 3 inches apart, thinned to 12 inches apart; quantity and quality of manure, 40 tons to Irish acre mixed dung, principally horse; time of sowing, first week in May; produce per Irish acre, 60 tons (leaves included).

1853.—*Grown by Mr. Robert Hawkins, Agriculturist of the Enniscorthy Union, Co. Wexford.*

Soil and subsoil, heavy clay, brick-clay subsoil; preceding crop, flax; method of cultivation, in drills 3 feet apart; quantity and quality of manure, 45 tons cowshed, with that from workhouse; time of sowing, second week in March, transplanted last week in May; produce per Irish acre, 40 tons.

1854.—*Grown by Mr. Robert Hawkins, Agriculturist of the Enniscorthy Union, Co. Wexford.*

Soil on which the crop was grown, strong clay; subsoil, brick-clay; preceding crop, turnips; method of cultivation, in drills, 3 feet apart; quantity and quality of manure, 55 tons of compost; time of sowing, transplanted the first week in May; produce per Irish acre, 40 tons.

1857.—*Grown by John E. V. Vernon, Esq., Clontarf.*

Seed sown in drills, with 5 lbs. of seed, and 30 tons of manure per acre, in April, after an oat crop; produce, 34 tons per acre.

1859.—*Grown by the Earl of Charlemont, Marino, Co. Dublin.*

Soil and subsoil, light loam on gravel; preceding crop, oats; method of cultivation, in drills 28 inches apart; quantity and quality of manure, 35 tons of farmyard compost; time of sowing, in March, on the seed-beds, and transplanted to the drills in June; quantity of seed, 4 lbs. per Irish acre; produce, 35 tons per Irish acre.

1859.—*Grown by the Marquis of Kildare, Kilkea Castle—James Alexander, Steward.*

Soil, black sandy loam; preceding crop, oats; method of cultivation, in drills 30 inches apart; quantity and quality of manure, 25 tons farmyard dung, and 3 cwt. Peruvian guano; time of sowing, first week in March; produce per Irish acre, 40 tons.

1859.—*Grown by Mr. Robert Boyle, Agriculturist, Glasnevin, Co. Dublin.*

Soil and subsoil, clayey loam on clay; preceding crop, potatoes; method of cultivation, in drills 30 inches apart, and 20 inches between the plants; quantity and quality of manure, 30 tons coal-ashes, nightsoil, &c.; time of sowing, 13th April; quantity of seed per acre, 4 lbs.; produce per Irish acre, 45 tons. *Note.*—In this crop the manure was applied in October, 1858, and the ground trenched.

1859.—*Grown by Joseph Radcliff, LL.D., Cliffe Lodge, Whitechurch, Rothfarnham.*

No. 1.—Soil, friable loam; subsoil, gravelly; preceding crop, oats; method of cultivation, in drills, transplanted from a seed-bed; quantity and quality of manure, 40 tons compost per Irish acre; time of sowing, end of April, transplanted to the drills beginning of June; produce per Irish acre, 40 tons. *Note.*—Salt was applied in the after-culture.

No. 2.—Soil, friable loam; subsoil, clay gravel; preceding crop, oats; sown in a seed-bed, and transplanted to drills; quantity and quality of manure, 40 tons compost per Irish acre; time of sowing, in April, in the seed-bed, and plants removed to the drills in June; quantity of seed per acre, 6 lbs.; produce, 45 tons per Irish acre.

No. 3 (*Oblong Purple variety*).—Soil, clay loam; subsoil, yellow clay; preceding crop, barley; grown in drills; quantity and quality of manure, 40 tons compost; time of sowing, 1st May; quantity of seed per acre, 4 lbs.; produce per Irish acre, 45 tons.

No. 4.—Soil, strong loam; subsoil, yellow clay; preceding crop, wheat; grown in drills; quantity and quality of manure, 40 tons compost; time of sowing, seed sown 20th April, and transplanted to the drills first week in June; quantity of seed per acre, 5 lbs.; produce per Irish acre, 50 tons. *Note.*—Salt was applied in the after-culture.

No. 5.—Soil, strong loam; subsoil, yellow clay; preceding crop, wheat; grown in drills; quantity and quality of manure, 40 tons compost; seed sown 20th April, and transplanted to the drills first week in June; quantity of seed per acre, 5 lbs.; produce, 50 tons per Irish acre. *Note.*—Salt applied in the after-culture.

No. 6.—Soil, clay loam; subsoil, very retentive; preceding crop, barley; mode of cultivation, in drills; quantity and quality of manure, 40 tons compost; sown in March in the seed-bed, and transplanted in May; quantity of seed per acre, 4 lbs.; produce, 58 tons per Irish acre.

1859.—*Grown by John E. V. Vernon, Esq., Clontarf.*

Soil, light, on a yellow clay subsoil; preceding crop, oats; grown in drills; quantity and quality of manure, 30 tons farmyard compost; time of sowing, 20th April; quantity of seed per acre, 4 lbs.; produce, 25 tons per Irish acre.

The record of these crops is important; but, except in the case of Dr. Radcliff's experiments, calls for no special remark.

The produce of the six lots grown by him shows a variation ranging from 40 to 58 tons per Irish acre, the lightest crop being raised on the friable loam on gravelly subsoil, and the heaviest on the clay resting on a very retentive subsoil. This result confirms the reports of previous experiments as to heavy land being best adapted for the plant. The reader must bear in mind that the weight of the crop in all these experiments is calculated by the Irish acre,* which is more than one-half larger than the imperial; the exact proportions being 1·62, or as 30¼ to 49. It may, perhaps, be more clearly stated by the relative money values, which are as follows:—

£.	s.	d.		£.	s.	d.	
0	2	6	per Irish acre is equal to	0	1	6½	per imperial acre.
1	0	0	" "	0	12	4	"

The Royal Dublin Society should insist on all returns being made in future according to the imperial standards. The local measures create great confusion when comparative results are required.

Other correspondents furnish us with sufficient data to assume, that from 26 to 30 tons per acre is the average produce in England, and from 20 to 25 in Scotland. This, however, must be taken with considerable reservation, as the data on which the average is founded are not of a sufficiently extensive character to warrant us in saying that these returns will hold good when Kohl-Rabi is more generally cultivated.

Although the collections of roots at the annual shows of the Smithfield Club form an attractive part of the exhibition, no premiums are offered as at Dublin, nor is any entry made in the catalogue issued by the Club. We are, consequently, without any record of either the growers or the produce. At the show in December last there were exhibited specimens of nearly all the known varieties of the Kohl-Rabi, and among them were single bulbs of the oblong green, weighing 15lbs., and of the oblong purple 17½lbs. Of the latter variety, Colonel North exhibited specimens weighing from 12 to 16lbs.; and of the former, the Earl of Essex sent specimens weighing 14 to 15lbs. At the exhibition of roots held at the Crystal Palace simultaneously with the Smithfield Show, some excellent roots were shown by Messrs. Sutton and Sons, Reading, weighing from 8 to 12lbs. To Colonel North, however, all the first prizes in the various classes were adjudged. Four varieties were represented—viz., the late green and purple, and the oblong green and purple varieties.

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* An Irish acre is 88½ yards square, and contains nearly 7840 square yards. An imperial or statute acre contains only 4840 square yards, the side of the square being 69½ yards.

The following particulars are from the Crystal Palace Prize List :—

1859.—*Grown by Colonel North, M.P., Wroxton Abbey, Banbury, Oxon. Round green Kohl-Rabi.*

Sown 29th March in a seed-bed in drills one foot apart, and transplanted in the field the last week in May; manured with 15 loads of farmyard-manure and 2 cwt. of Proctor and Ryland's turnip-manure per acre; soil, a rocky loam; previous crop, wheat.

It is unnecessary to give the particulars of the three other classes, for all were grown on the same description of soil, and treated in a like manner.

As to the average weight of single bulbs, we have access to more reliable data than in estimating the average produce of an acre. The two oblong varieties may be set down at 7 lbs., the round at 6 lbs. Estimating the weight of an acre from the average of a single bulb, affords a striking proof of its fallacy; and yet how very plausible it appears, and how very correct it *ought* to be. Here is the calculation and its result:—assuming the drills to be 27 inches apart, and the distance between each plant 12 inches, this will give 19,360 plants to the acre. Taking 6 lbs. as the average weight of the round varieties, 51 tons 18 cwt. per acre should be produced, and with the bulbs at 7 lbs. no less than 60 tons 11 cwt.! This is certainly a possible return, but not a very probable one. One inch difference in the distance between the plants, or say 11 instead of 12 inches, will, in the case of the 6lb. bulb, increase the return to 56 tons 11 cwt., and with the 7 lb. bulb to 66 tons per acre. If the average weight of the bulb be 8 lbs. instead of 7 lbs., then we *ought* to get 75 tons and 8 cwt. These facts afford matter for the serious consideration of the grower not only of Kohl-Rabi, but of turnips; showing, as they do, how very materially the value of his crop may be affected by a careless worker dibbling the plants even a single inch wider apart than is necessary.

Consumption of the Crop by Live Stock.

All the domesticated animals feed on Kohl-Rabi with avidity, and even reject turnips for it. The farmer has merely, therefore, to determine the most profitable mode of consuming it. And in endeavouring to point this out, we shall bring together the most trustworthy opinions we have been enabled to procure; our own experience not affording any reliable evidence on this point.

As the leaves afford the same amount of nutritive matter as the bulbs (as will be shown when treating of the chemistry of the plant), and as all our correspondents agree in stating that they are eaten with avidity by both milch cows and ewes; the best

and most judicious method of securing this portion of the crop, becomes a most important subject for consideration. Unfortunately, we have no experience on the large scale to guide us; but a parallel case, in regard to stripping the leaves of the mangold-wurtzel (a member of the natural order Chenopodiacæ), having recently been published* from the pen of Mr. William Boyle of Glasnevin, we think it right to draw attention to it, and to recommend the practice for experiment with the Kohl-Rabi:—

"As the leaves of mangolds have always been found on this farm to possess valuable feeding properties when given to the milch cows, it has been the custom for several years past to carefully and judiciously pull off the drooping leaves from the middle of August to the middle of October. An experiment was instituted last season, and carefully carried out on a pretty large scale, with the view of determining whether the roots gained or lost in weight by the stripping off, at intervals, of the falling outside leaves. The leaves, it must be borne in mind, were most carefully and rather sparingly removed at the first and second strippings, and not more than 3 or 4 taken from a plant at one time. In this way 5 tons of leaves per statute acre were taken off for feeding purposes from the 12th of August to the 15th of October. The experiment was carried out on 4 acres of the mangold crop—12 drills, each 200 yards in length (that being the entire length of the field), were left untouched, whilst the remaining portion of the crop was treated as above detailed. It is deserving of remark that there was no apparent difference in the two lots at any period during the season, and the crop was considered by the numerous visitors to the institution and farm as a remarkably even and regular one.

"The following table shows the result of the experiments, and the manures employed for the general crop, &c.:—

No. of Lot.	Variety of Mangold.	Date of Sowing.	Manures employed per Statute Acre.	Leaves taken off per Statute Acre.	Weight of Bulbs per Statute Acre.	Date of Lifting.
				tns. cwt. st.	tns. cwt. st.	
1	New Oval Yellow	April 23	30 tons of farmyard, 1 cwt. of Peruv. guano, 6 cwt. of common salt	5 0 0	45 1 0	Oct. 27
2	Do.	Do.	Do.	None	40 8 6	Do.

"The result here given was not altogether unexpected, as in former years the crop did not appear to suffer from the removal of those leaves which were believed to have ceased to perform their special functions, as indicated by their drooping appearance and somewhat altered colour; but that so considerable an addition to the weight of the crop should have arisen from taking off the leaves was not by any means anticipated.

"It is true that the removal of the leaves admitted a freer current of air to the plants, and also exposed them to a greater degree of light, two agents which must exert important influences on the growth of plants, and it remains for vegetable physiologists and agricultural chemists to say whether this freer exposure to the air and light could have such an effect on the plant as to increase

* See No. 1 of the 'Agricultural Gazette' for January 7, 1860, p. 11.

the size or specific gravity of the bulbs.* The experiment, as has been already remarked, was most carefully carried out, and the circumstance of so considerable an extent of crop being experimented upon, added to the fact that the entire crop of both leaves (removed) and roots having been accurately weighed, give it a reliable character.

"That the free admission of light and air tends to increase the weight of the roots appears to be confirmed by the fact that the outside drill, which we have weighed separately for some years, produces at the rate of several tons per acre more than the general crop. I should also observe that the variety of mangold experimented upon returns a greater weight of leaves (and also of roots) per acre than any other kind we grow; and it may be found that the removal of a certain quantity of leaves from this particular sort will have a different effect from that produced by taking off the same quantity from another kind whose leaves would be 20 or 30 per cent. less, all other circumstances being equal."

Mr. Innes, of Wroxton Abbey, writing under date 4th January, 1860, says, "At this moment my sheep are folded on this root, and eating it off like swedes, and apparently are doing very well with it; whereas the greater portion of my early-sown swedes are destroyed by the frost, and of no value for food. The time when the Kohl-Rabi is most useful is in the spring, when the ewes are lambing, as it is found greatly to increase the supply of milk. I give mine also to milch cows in the winter, when they are unable to obtain grass." From the root being firmly fixed in the earth, and the bulb growing clean out of the soil, the Kohl-Rabi seems specially adapted for feeding sheep on the ground; as every portion of it can be eaten, and not a particle destroyed by being trodden under foot. Mr. Innes has likewise a field in which the Kohl-Rabi is alternated with Swedes, thus:—

Swedes.	Kohl-Rabi.	Swedes.	Kohl-Rabi.	Swedes.
—	—	—	—	—
8 rows.	8 rows.	8 rows.	8 rows.	8 rows.

This was done for the purpose of drawing off the Kohl-Rabi to be given to milch cows, and feeding off the swedes on the land by sheep.

Mr. William Kelly, Portrane, says in reply to an inquiry, "I

* The following remarks of Prof. Balfour, Professor of Botany, Edinburgh, and the late distinguished chemist, Dr. George Wilson, appear to have some bearing on this matter. "The function of the leaves," says Prof. Balfour, "is to expose the juices of the plants to light and air, and thus to aid in forming the woody matter of the stem and the various secretions. Unless the leaves are freely exposed to air and light, the wood is not properly formed. Hence the reason why the wood is deficient both as regards quantity and quality in trees grown in crowded plantations. The same observations apply to all the secretions of plants." Dr. Wilson remarked:—"It appears beyond doubt that the force generated by the sun, and conveyed by his rays in the guise of heat, light, and chemical power, to the earth, is not extinguished there, but only changes its form. It apparently disappears when it falls upon plants, which never grow without it; but we cannot doubt that it is working in a new shape in their organs and tissue."

prefer giving the roots to sheep on the grass without being cut or sliced." This method of consuming them is opposed to the practice of all our other correspondents.

Mr. James Alexander, steward to the Marquis of Kildare, informs us that he has grown Kohl-Rabi for the last thirty years; that cattle and sheep are fond of it in a raw state, and that pigs will thrive on it when boiled or steamed.

Mr. William Boyle, Glasnevin, says in his letter, "I have fed sheep with them in the spring, and for this purpose they are excellent. Every description of live stock will eat the Kohl-Rabi."

Mr. Towers* says, "During the parching summer of 1847, the plants grew on and retained their highest verdure. Sheep were found to thrive particularly well upon the plant in the succeeding winter; and we know that, ever since that year, beasts have been fatted by the bulbs; and vast numbers of sheep were, not long since, folded on the large breadths of land occupied by the August transplantings, which yielded abundance of green fodder, after Christmas, 1850."

Our great Scotch authority, Mr. Henry Stephens, says,† "It is an excellent food for cows and horses, and when boiled with grain for their use, will afford them true nourishment. The leaves may be also used, having entirely the character of a true cabbage; but they should be removed with a sparing hand, else the enlargement of the bulb will be prevented." This recommendation is at variance with the successful experiment of Mr. Boyle (see *supra*); but notwithstanding, we should like to hear of his experiment being repeated on the Kohl-Rabi.

Mr. Hewitt Davis observes: ‡—"I have given the bulbs without the leaves, freely to milch cows all the winter, and I find they prefer them to mangold-wurtzel, and thrive better on them; their milk is richer, and I have experienced no ill flavour in the butter. I fancy, too, the sheep I have fed on them have fattened faster than I have ever before had sheep do at this season. A flock of ewes with their lambs intended for spring killing have also for some time been feeding on this root, and never have I had a flock do better."

Our correspondents generally are of opinion that for winter feeding it is advisable either to slice, pulp, or steam the bulbs before giving them to either cattle or sheep. For pigs, steaming is to be preferred.

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* Morton's 'Cyclopædia of Agriculture.' Art. "Kohl-Rabi."

† 'Book of the Farm,' 2nd ed. vol. ii. p. 88.

‡ 'Farming Essays,' p. 90.

Chemistry of the Kohl-Rabi.

Mr. George Sinclair, in 1824, gave the result of his investigations into the nutritive value of the Kohl-Rabi,* as obtained by chemical analysis, in comparison with other field-crops. He arrived at his conclusions in this manner: From Arthur Young's 'Annals' and the Agricultural Surveys of the different counties, published under the authority of the Board of Agriculture, he obtained his data for estimating the average tonnage per acre of the different crops. Under Sir Humphry Davy's instructions, he worked out an analysis of a single pound weight of each variety, giving the amount of nutritive matter therein in grains; and this quantity, multiplied by the number of pounds in the tonnage per acre, gave his results. For instance, Kohl-Rabi was estimated to yield 14 tons per acre, or 31,360 lbs. A single pound of it yielded 420 grains of nutritive matters; this quantity, multiplied by the number of pounds per acre, yielded precisely 1881 lbs. The crops analyzed by him were mangold-wurtzel, carrots, potatoes, white turnips, swedish turnips, cabbages, and Kohl-Rabi. The following table, arranged in the order of the production of nutritive matter per acre, will show the position occupied by Kohl-Rabi in these ingenious, though practically useless, investigations.

	Number of Grains of Nutritive Matter in 1 lb.	Average Weight of Crop per Acre.	Weight in lbs. per Acre.	Weight of Nutritive Matter per Acre.	Proportions in which they stand to each other with respect to the Weight of Nutritive Matter per Acre.	Proportions which the Crops bear to each other in respect to Weight of Produce.
	grains.	tons.	lbs.	lbs.		
Potatoes	1000	15	33,600	4800	63	15
Cabbages	430	25	56,000	3440	42	25
Mangold-wurtzel	390	25	56,000	3120	28	25
Carrots	750	11	24,640	2640	24	11
Kohl-Rabi	420	14	31,360	1881	17	14
Swedish Turnips	440	13	29,120	1830	16	13
White Turnips	320	16	35,840	1638	14	16

The researches of Way and Ogston, published in this *Journal*: of Professor Johnston; his assistant, Mr. Fromberg; of Dr. Voelcker and Professor Anderson, have put the relative nutritive properties of these crops in a correct light, and show the incorrectness of Sinclair's conclusions. The table, therefore, may be regarded as a curiosity merely, and as the first result of a search after truth.

* 'Hortus Gramineus Woburnensis.' London: James Ridgway.

In 1850, Messrs. Way and Ogston published their inorganic analysis of the Kohl-Rabi.* It is as follows:—

	Water.	Ash.	Ash calculated on Dry Substance.
Bulbs	88·24	0·95	8·09
Leaves	84·89	2·80	18·54

The composition of the ash in 100 parts is as follows:—

	Bulbs.	Leaves.
Silica	0·82	9·57
Phosphoric acid	13·46	9·43
Sulphuric acid	11·43	10·63
Carbonic acid	10·24	8·97
Lime	10·20	30·31
Magnesia	2·36	3·62
Peroxide of iron	0·38	5·50
Potash	36·27	9·31
Soda	2·84	0· 0
Chloride of potassium	0· 0	5·99
Chloride of sodium	11·90	6·66
	100·00	99·99

"The above composition is in many respects similar to that of turnips, and does not require any special comment."

Being desirous of ascertaining the actual amount of nutritive matter in the Kohl-Rabi, as compared with swedish and common turnips, our friend Dr. Anderson, chemist to the Highland and Agricultural Society of Scotland, kindly undertook the investigation; and his report, sent to us only on the 4th of January, is as follows:—

	Bulbs.	Leaves.
Water	86·74	86·68
Albuminous compounds	2·75	2·37
Respiratory principles	8·62	8·29
Fibre	0·77	1·21
Ash	1·12	1·45
	100·00	100·00
Nitrogen	0·44	0·38

In a note, accompanying the analysis, Dr. Anderson says:—

"You will observe that, both in point of composition and feeding value, the bulbs and leaves are quite identical. They are about twice as valuable as ordinary turnips, and materially surpass the best swedes, which rarely contain more than 9 or 10 per cent. of solid matters, and about 1·5 per cent. of albuminous compounds."

This investigation is very satisfactory, in so far as its results show the importance of the Kohl-Rabi as a *feeding* plant, and as a profitable substitute for the turnip; independently of its valuable properties as a field crop, in its freedom from disease, and its power of withstanding frost.

* 'Journal of the R. A. S. E.,' vol. xi. p. 511.

Diseases, Insects, and Accidents.

Of all the cultivated plants of the farm, the Kohl-Rabi is the hardiest and the least liable to disease. It is attacked, although rarely, by "anbury," and also by "clubbing." The former never assumes its virulent stage in the Kohl-Rabi, so far as our own observations extend. The latter, which is sometimes mistaken for the incipient stages of "anbury," makes its appearance on the stem, a little above the root, in the form of a small gall or wart, which gradually enlarges. On the excrescence being opened, a small dusky maggot is found, said to be the larva of the cabbage-fly (*Anthomyia brassicæ*), although others affirm it to be the larva of *Curculio contractus.* Where a number of these are present and a congeries of warts is found, the plant becomes unhealthy and never arrives at perfection. It is said to affect plants raised on soil where continued crops of the brassica tribe have been raised. Change of soil, if this theory be correct, will afford a remedy. Where "clubbing" is present in the seed-bed, a direct application of the following composition may be resorted to:—

Fresh soot	1 gallon.
Powdered saltpetre	1 lb.

Add water sufficient to reduce it to the consistency of coal-tar, and, as the plants are lifted from the seed-bed they should be dipped into this composition before transplanting to the drills.

The common cabbage aphis (*Aphis brassicæ*) attacks the Kohl-Rabi, swarming on the under side of the leaves, but we never saw them on the purple varieties. They generally make their appearance about the end of July.

Hares and rabbits are most destructive enemies of the Kohl-Rabi, and where they abound the damage done to the crop is very great. A ridge or two of carrots and parsley between the Kohl-Rabi and their cover will supply them with a food they prefer, and the crop may by these means be preserved. This precaution should be adopted in advance of the transplanting, for a ridge of carrots and parsley cannot be placed there after the animals commence their depredations.

Practical Opinions on the Culture of Kohl-Rabi.

This Paper will hardly be considered complete without recording the result of the cultivation of the Kohl-Rabi by a few, at least, of our practical agriculturists. The evidence in its favour, indeed, is so complete and so generally acknowledged, that it is matter of surprise to find its cultivation so limited. We can only

account for it on the supposition that no attempt has hitherto been systematically made to introduce it to the notice of the farmer, and that the results of experiments have been confined to occasional paragraphs in agricultural journals and local newspapers.

Mr. Towers says: *—

"In 1837, our turnips were so mangled and honeycombed by a grey caterpillar that they became worthless, and many persons substituted Kohl, but relinquished it too speedily, returning to their playing at turnips. The Kohl of this year I have found to resist the utmost drought of our most arid summer; and about September, when the wheat lands received the first scanty showers, the stubbles were twice or three times ploughed, manured, and thoroughly harrowed. Upon ground so prepared, the late crop of seedling Kohl was set by dibble, but the plants nearer to each other in the rows. So dry was the season, that before ten acres of one noble field could be planted six weeks had elapsed; yet all are now flourishing, and will come in for spring food. The most delightful and benign rains of October scarcely excited the miserable turnips, yet every plant of the Kohl felt their influence, and is progressing to perfection. This fine vegetable, therefore, being proof against aridity, moisture, or frost, and defying insect ravage, is earnestly recommended as a substitute in those localities where the weak and miffy turnip is ever a subject of doubt and perplexity."

And again: †—

"I have seen in the present year on a 60-acre farm one *first* main plantation for early bulbs; a second of larger extent after Early Shaw potatoes; a third after the first corn-crop; and as there are thousands of seedlings yet in the seed-beds, I think it likely that another plot of several acres will be occupied by plants intended for spring food, if not for the production of seed. I close this communication by an extract from a note received on the 3rd September from a first-rate grower, on the subject of the acreable yield:—'As the weight of bulbs from an acre was never taken, it cannot be exactly given; but having grown bulbs weighing 16 lbs. and 17 lbs. each, although they are set out *thinner* than swedes, they are more *certain*. They retain their leaves all winter, and I consider I can grow as much weight per acre, weighed in January, as of swedes; and certainly I give the preference to Kohl-Rabi as to comparative nourishment. Unfortunately, it has seldom justice done to it: the seed is sown too late, and the planting made so likewise. It is a most valuable root.' As to mildew or disease, I never saw or heard of either; and I can distinctly add that I observed the plants to thrive better in the dry summers of 1847 and 1849 than during the intermediate wet one of 1848."

Mr. Henry Stephens says: ‡—

"As Kohl-Rabi holds the same position as a crop as the turnip, its culture is very similar; but while turnips affect the lighter soils, Kohl-Rabi thrives on the stronger, *so it may be raised where turnips cannot be*. . . . Specimens of Kohl-Rabi have been raised in Scotland weighing from 5 to 7½ lbs.; in Ireland individual bulbs have attained the weight of 14 lbs., and in England they commonly reach from 8 to 10 lbs. . . . The advantages which Kohl-Rabi is said to possess over Swedish turnips by those who have cultivated it in England and

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* From a Scotch newspaper; name and date not known.

† 'Journal of the R. A. S. E.,' vol. xi. p. 496.

‡ 'Book of the Farm,' 2nd ed., vol. ii., pp. 87, 88.

Ireland are these :—cattle, and especially horses, are fonder of it; the leaves are better food; it bears transplanting better than any other root; insects do not injure it; drought does not prevent its growth; it stores quite as well or better; it stands the winter better; and it affords food later in the season, even in June."

Mr. William Boyle, of the Model Farm, Glasnevin, says :—

"As Kohl-Rabi is much hardier than either swedes or mangold-wurtzel, and will keep over to May or June without failure, I think the crop deserves a fair trial as an auxiliary to the usual green crops."

Mr. Hewitt Davis * thus testifies in favour of the Kohl-Rabi :—

"My success in growing heavy crops of this root for some years upon poor soils—and, more particularly, the contrast their goodness this year presents to the general failure in the south of England of swedes and turnips from the summer drought—induces me to bring its valuable qualities under more general notice. . . . It is not attacked in the field by the fly, nor liable to the casualties that turnips are exposed to. . . . Very hardy, withstanding frost, and affords more late winter cattle-food to the acre than any other vegetable that I am acquainted with. . . The value of this root in any season is very considerable, but more particularly after a dry summer, when most other winter food is scarce. I am this year very fortunate, having on each of my farms a considerable breadth; and I so much approve of it, that I intend never being without it. Lean stock, after such a season as we have just had, always sell low in the autumn from the want of winter keep; whilst fat stock in the following spring, from the same cause, usually sell very high, so that a plant of this description is most advantageous. Upon a field of ten acres, broken up from heath last year, I have at this moment more winter food to the acre than is commonly grown on good soils in favourable seasons from any other root."

It is needless extending further the evidence in favour of the general cultivation of the Kohl-Rabi, either as supplementary to swedes, or as a substitute for them. The result of very extensive inquiries among growers, leads us only to wonder that it has not, ere this, come into general use—the evidence in its favour being so complete wherever an experiment has been made. The absence of published information in regard to it, and the ignorance of its properties and value as a *farm* crop, even in districts where its use as a garden vegetable has long been known, can alone account for the neglect to which it has been subjected. Let us hope that, through the publicity now given to it among the members of the Royal English Agricultural Society, some, at least, of our more enterprising agriculturists will introduce it to their farms, and duly record their experience of its properties as a plant fitted to take its place in the ordinary rotations of cropping.

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* 'Farming Essays,' No. xvi. p. 70.

General Summary.

The following general summary of the foregoing Paper may be useful, in bringing under one view the special features of the Kohl-Rabi, and the various points to be noticed in the cultivation, general management, properties, and uses of the plant:—

1. There are eleven varieties in cultivation, four of which are supposed to be modifications of the others.

2. All soils are suited to its cultivation, but it prefers heavy lands, even those approaching to stiff clays, and it can be grown where turnips cannot.

3. Soil should be in fine tilth, well worked, and farmyard manure ploughed-in in the autumn. In the spring it should be grubbed and thoroughly pulverized.

4. It requires heavy manuring: phosphatic manures, with common salt added, are most suitable for it. Peruvian guano and other nitrogenous manures should be avoided.

5. Seed should be sown in beds at the end of February or early in March, in drills 12 inches apart. A bed 6 yards square will afford sufficient plants for one acre of land, and 8 oz. of seed will be necessary for the seed-bed.

6. For successional crops, three sowings may be made: the first, early in March; the second, during the second week of April; and the third, the first week of June.

7. Transplanting to the drills should be commenced the first week of May; but, as a general rule, the plants should not be removed until they are from 6 to 8 inches high.

8. Plants for the main crop should be dibbled in at 18 inches distance. If successional crops are transplanted, the first (in May) should be 18 inches; the second (in June) 16 inches; and the third (end of July or first week in August) 14 inches, apart.

9. If sown at once in the field in the drills, the operation should be performed about the middle of April, but not later than the end. Of seed, 4 lbs. are necessary for an acre.

10. Drills should be 27 inches in width, and plants should be singled to 18 inches.

11. While growing, the horse-hoe must be kept in continual requisition, until the spreading of the leaves prevents the operation being performed.

12. The average weight per acre is in England from 26 to 30 tons; in Scotland, from 20 to 25 tons; and in Ireland from 30 to 35 tons.

13. Every description of stock will eat the Kohl-Rabi with avidity. In consuming the crop, sheep may be folded on the ground; but, if given in the yards to cattle, the bulbs should be sliced or pulped. For pigs they should be steamed or boiled.

14. For cattle and horses it affords true nourishment when boiled with grain.

15. For milch cows it is invaluable, giving to milk or butter none of that disagreeable flavour which results when they are fed on turnips.

16. For ewes and lambs it is as fine food as they can have in March and April; and when the ewes are lambing it is found greatly to increase the supply of milk.

17. Kohl-Rabi is, so far as at present known, subject to no diseases except "clubbing" and "anbury."

18. If hares or rabbits exist in the neighbourhood of the crop, they are sure to prove very destructive unless means of precaution are taken.

19. The leaves are of equal value with the bulbs in nutritive properties.

20. The plant for feeding purposes is twice as valuable as ordinary turnips, and materially surpasses the best swedes in point of composition and feeding value.

21. It bears transplanting better than any other crop, and is invaluable, therefore, for filling up blanks in turnips, swedes, or potatoes.

22. The Kohl-Rabi can withstand any amount of drought, if the operation of transplanting has been successful.

23. The most intense frost does not affect it; it stands the winter well, and affords good feed even to the end of spring.

24. Its advantages over the swedes are, that cattle, and especially horses, are fonder of it; the leaves are better food; it bears transplanting better than any other root; insects do not injure it; drought does not prevent its growth; it stores quite as well or better; it stands the winter better; and it affords food later in the season, even in June.

END OF VOL. XX.

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1859—1860.

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MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the new postal district designated by the letter W, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, on Friday, December 9, at Eleven o'clock, A.M.

GENERAL MEETING in London, May 22, 1860, at Twelve o'clock.

COUNTRY MEETING at Canterbury, in 1860.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Easter, Passion, and Whitsun weeks, when those weeks do not include the first Wednesday of the month; from the first Wednesday in August to the first Wednesday in November; and from the first Wednesday in December to the first Wednesday in February.

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(A statement of these privileges will be found in the present Appendix, p. xl.)

CHEMICAL ANALYSIS.—The privileges of Chemical Analysis enjoyed by Members of the Society will be found stated in the Appendix of the present volume, p. xxxix.

LOCAL CHEQUES.—Members are particularly requested not to forward Country Cheques for payment in London; but London Cheques, or Post-office Orders (payable to "The Secretary"), in lieu of them. All Cheques are required to bear upon them a penny draft or receipt stamp, which must be cancelled in each case by the initials of the drawer. They may also conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4 ounces	(or quarter of a pound) . . .	1 penny.
,, ,, ,,	8 ,,	(or half a pound)	2 pence.
,, ,, ,,	16 ,,	(or one pound)	4 ,,
,, ,, ,,	24 ,,	(or one pound and a half) . .	6 ,,
,, ,, ,,	32 ,,	(or two pounds)	8 ,,

[And so on in the proportion of 8 ounces for each additional 2*d.*]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, of Chemical and Veterinary Privileges, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Monday, May 23, 1859.

REPORT OF THE COUNCIL.

The Society consists at the present time of—

78 Life Governors,
130 Annual Governors,
927 Life Members,
4008 Annual Members, and
18 Honorary Members,

making a total of 5161 names on the list. The Council has elected Lord Leigh, of Stoneleigh Abbey, a member of the Council, to supply the vacancy caused by the resignation of Sir Archibald K. Macdonald, Bart.

The funded capital of the Society stands at 10,000*l.* stock, in the New Three per Cents.

The Council has appointed Professor Spooner, of the Royal Veterinary College, joint Veterinary Inspector with Professor Simonds, at the Annual Country Meetings of the Society. This step has been found necessary in order that every facility may be afforded for a thorough examination of the animals sent to the shows, more especially as to their freedom from any hereditary diseases, which might be transmitted to their progeny; and also as to whether the state of dentition fully bears out the ages stated in the certificates.

The Council has decided that Professor Voelcker, the Society's Consulting Chemist, shall investigate the following subjects :—

1st. The changes that take place in liquid manures in passing through different soils.

2nd. Experiments on top-dressing wheat and barley.

3rd. The different modes of applying manure in autumn and spring.

4th. The nature and physiology of cultivated turnips, being a continuation of his experiments connected with this subject.

The Council has determined to amend the wording of the rule regulating the members' privilege of analysis, so as to prevent dealers or manufacturers of manures availing themselves of the reduced scale of charges which has been secured for the benefit of such members as may require analyses *bonâ fide* for their own personal use as agriculturists.

The Warwick Meeting (to be held in the week commencing Monday, July 11th) promises to be of a highly interesting character. The arrangements for the meeting are steadily progressing. The entries for implements are so extremely large as to require six sheds to be added to last year's plans, in the implement department alone; and the applications for space in the yard devoted to "machinery at work" are also far greater than on any former occasion. The numerous applications for certificate-forms that are being received daily indicate that the live-stock portion of the show will at least be equal to any former exhibition.

The local committee at Warwick, having declined to undertake the arrangements and liabilities connected with the dinner during the Society's meeting, the Council has determined to adhere to the resolution of last year—not to take these responsibilities on itself on the present occasion. The special attention of the General Warwick Committee has been directed to the subject of the supply of refreshments for visitors in the show-yard during the exhibition; and such arrangements have already been made and are still in progress as, it is hoped, will secure to the public due accommodation in this respect at a fixed tariff of charges.

Since the Society first prominently drew attention to the important subject of the application of steam-power to the cultivation of the soil, by offering a special prize of large amount, several inventions and improvements have been brought before the public; and the advancement made was such as to lead the Council to award the prize of 500*l.* at the Chester Meeting last

year. As no doubt further improvements have since been made, it may be confidently expected that the trials to be carried on at Warwick, under the direction of the Society's Judges, will prove an interesting feature in the meeting, by affording agriculturists an opportunity of personally inspecting the different inventions that will then be brought together in competition.

The Council has decided that the Country Meeting of next year, for the South-Eastern district (comprising the counties of Kent and Surrey), shall be held at the city of Canterbury. The accommodation offered and guaranteed by the authorities promises to be unusually convenient and complete.

The Council has the satisfaction of recording that the interest taken by agriculturists generally in these annual exhibitions appears steadily to increase, and that year by year greater anxiety is manifested by the authorities and inhabitants of the principal towns within the district proposed to be visited to secure the Society's meeting in their respective localities, and to offer every facility in their power to aid the Council in carrying it to a successful issue.

In conclusion, the Council congratulate the members on the steady progress of the Society in accomplishing the various important objects for which it was established.

By order of the Council,

B. T. Brandreth Gibbs,

Hon. Sec. *pro tem.*

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-Yearly Account, extending from the 1st of July to the 31st of December, 1858.

Receipts.

	£.	s.	d.
Balance in the hands of the Bankers, July 1, 1858	2225	15	9
Petty Cash Balance in the hands of the Secretary, July 1, 1858	3	14	4
Dividends on Stock	146	17	6
Governor's Life-Composition	50	0	0
Governors' Life-Subscriptions	30	0	0
Members' Life-Compositions	167	0	0
Members' Annual Subscriptions	664	2	0
Journal Receipts	187	8	6
Sale of Horse-shoeing Tracts	17	18	10
Country-Meeting Receipts:—			
Salisbury	14	1	0
Chester	4566	15	7
	£8073	13	6

Payments.

	£.	s.	d.
Permanent Charges	179	17	6
Taxes and Rates	15	17	6
Establishment	631	8	3
Postage and Carriage	18	14	2
Advertisements	7	7	6
Journal Payments	648	2	6
Essay Prizes	120	0	0
Veterinary Grant	100	0	0
Chemical Grant	150	0	0
Country Meeting Payments:—			
Chester	4792	8	1
Subscription (paid in error by Banker) returned	5	0	0
Purchase of 735*l.* 11*s.* 1*d.* Stock in the New 3 per Cents.	717	3	4
Sundry items of Petty Cash	4	7	9
Balance in the hands of the Bankers, Dec. 31, 1858	649	11	6
Petty-Cash balance in the hands of Secretary, Dec. 31, 1858	33	15	5
	£8073	13	6

(Signed) THOMAS RAYMOND BARKER, *Chairman*, C. B. CHALLONER, } *Finance Committee.*

Examined, audited, and found correct, this 20th day of May, 1858.

(Signed) JOSEPH DRUCE, GEORGE T. RAYMOND BARKER, } *Auditors on the part of the Society.*

SHOW AT WARWICK: JULY, 1859.

STEWARDS OF THE YARD.

Stewards of Cattle.

Robert Smith.
Richard Milward.
W. Fisher Hobbs.

Stewards of Implements.

Charles Barnett.
H. B. Caldwell.
Edward Pope.

Steward of Cheese and Wool.

Thomas Pain.

Honorary Director of the Show.

B. T. Brandreth Gibbs.

JUDGES.

Short-horns.

John Wright,
Charles Stokes,
James Topham.

Herefords and Devons.

Henry Trethewy,
Edward Lane Franklin.

Other Breeds and Local Cattle.

John Parkinson,
John Clayden,
John B. Thompson.

Horses.

W. C. Spooner,
C. Randell,
John Morley.

Thomas Brooks,
Henry Thurnall.
J. H. Bland.

Leicester Sheep.

Richard Hewitt,
N. C. Stone,
John Bodley.

Southdown Sheep.

Henry Fookes,
Henry Lugar,
Edward Trumper.

Long-woolled Sheep (not Leicesters).

William Bartholomew,
Henry Bateman,
Henry Beevor.

Short-woolled Sheep (not Southdowns).

Joseph Blundell,
James Rawlence,
James Burgess.

Pigs.

Rev. C. T. James,
James Singer Turner,
Joseph Woolf.

Implements.

William Owen, c.e.,
Joseph Druce,
John Thompson,
J. J. Rowley,
John Brasnett,
John Hicken,
G. M. Hipwell,
John Clarke,
William Tindall.

Cheese.

James Watson,
J. W. Daniel.

Wool.

Henry B. Hughes.

Veterinary-Inspectors.

Professor Spooner,
Professor Simonds,
Royal Veterinary College.

Consulting-Engineer.

Charles Edwards Amos,
(Firm of Easton and Amos).

AWARD OF PRIZES.

Cattle: *Short-Horns.*

John H. Bradburne, of Pipe Place, near Lichfield, Staffordshire: the Prize of Thirty Sovereigns, for his 4 years-old Bull; bred by Edmund Lythall, of Radford Hall, near Leamington.

Hon. Colonel Pennant, M.P., of Penrhyn Castle, near Bangor, Carnarvon: the Prize of Fifteen Sovereigns, for his 4 years-old Bull; bred by J. S. Tanqueray, of Brent Cottage, near Hendon, Middlesex.

Stephen Gooch, of Honingham, near Norwich: the Prize of Five Sovereigns, for his 2 years and 7 months-old Bull; bred by himself.

Lieutenant-Colonel Charles Towneley, of Towneley Park, near Burnley, Lancaster: the Prize of Twenty-five Sovereigns, for his 1 year and 10 months-old Bull; bred by himself.

Henry Ambler, of Watkinson Hall Farm, near Halifax: the Prize of Fifteen Sovereigns, for his 1 year and 8 months-old Bull; bred by William Carr, of Stack House, Settle, Yorkshire.

John Lynn, of Stroxton, near Grantham, Lincoln: the Prize of Five Sovereigns, for his 1 year and 11 months-old Bull; bred by the late Robert Lynn, of Stroxton.

William Fletcher, of Radmanthwaite, near Mansfield, Notts: the Prize of Ten Sovereigns, for his 9 months-old Bull-calf; bred by himself.

Richard Stratton, of Broad Hinton, near Swindon, Wilts: the Prize of Five Sovereigns, for his 10 months-old Bull-calf; bred by himself.

Richard Stratton, of Broad Hinton: the Prize of Twenty Sovereigns, for his 4 years-old Cow, In-milk; bred by himself.

Richard Eastwood, of Swinshawe, near Burnley, Lancaster: the Prize of Ten Sovereigns, for his 3 years-old Cow, In-milk and In-calf; bred by Mr. Wetherell, of Aldbrough, near Darlington.

William Tod, of Elphinstone Tower, near Tranent, Haddington: the Prize of Five Sovereigns, for his 8 years-old Cow, In-milk and In-calf; bred by Mark Stewart, of Southwick, near Dumfries.

Lieutenant-Colonel Charles Towneley, of Towneley Park: the Prize of Fifteen Sovereigns, for his 2 years-old, In-calf Heifer; bred by himself.

Francis Fowler, of Henlow, near Biggleswade, Beds: the Prize of Ten Sovereigns, for his 2 years-old In-calf Heifer; bred by himself.

Lieutenant-Colonel Charles Towneley, of Towneley Park: the Prize of Five Sovereigns, for his 2 years and 7 months-old In-milk and In-calf Heifer: bred by himself.

John Grundy, of The Dales, Stand, near Manchester: the Prize of Fifteen Sovereigns, for his 1 year and 9 months-old Heifer; bred by himself.

James Douglas, of Athelstaneford Farm, near Drem, Haddingtonshire, the Prize of Ten Sovereigns, for his 1 year and 10 months-old Heifer: bred by himself.

Captain Gunter, of The Grange, near Wetherby, York: the Prize of Five Sovereigns, for his 1 year and 7 months-old Heifer: bred by himself.

Cattle: *Herefords.*

Richard Hill, of Golding Hall, near Shrewsbury: the Prize of Thirty Sovereigns, for his 2 years and 10 months-old Bull; bred by himself.

Lord Berwick, of Cronkhill, near Shrewsbury: the Prize of Fifteen Sovereigns, for his 4 years and 6 months-old Bull; bred by himself.

JOHN WILLIAMS, of St. Mary's, Kingsland, near Leominster, Herefordshire: the Prize of TEN SOVEREIGNS, for his 2 years and 10 months-old Bull: bred by himself.

JOHN NAYLOR, of Leighton Hall, near Welshpool, Montgomeryshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 9 months-old Bull: bred by Edward Thomas, of The Lodge, Delbury, near Munslow, Salop.

WILLIAM PERRY, of Cholstrey, near Leominster: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 11 months-old Bull: bred by himself.

THOMAS EDWARDS, of Wintercott, near Leominster: the Prize of FIVE SOVEREIGNS, for his 1 year and 9 months-old Bull: bred by himself.

HIS ROYAL HIGHNESS THE PRINCE CONSORT: the Prize of TEN SOVEREIGNS, for his 11 months-old Bull-calf; bred by himself.

CHARLES VEVERS, of Ivington Park, near Leominster: the Prize of FIVE SOVEREIGNS, for his 11 months-old Bull-calf; bred by himself.

THOMAS REA, of Westonbury, Pembridge, Herefordshire: the Prize of TWENTY SOVEREIGNS, for his 3 years and 7 months-old, In-calf Cow; bred by James Rea, of Monaughty, Knighton, Radnorshire.

LORD BERWICK, Cronkhill, Shrewsbury: the Prize of TEN SOVEREIGNS, for his 3 years and 11 months-old In-milk Cow; bred by himself.

REES KEENE, of Pencraig, near Caerleon, Monmouthshire: the Prize of FIVE SOVEREIGNS, for his 4 years and 8 months-old Cow; bred by himself.

JAMES REA, of Monaughty, near Knighton, Radnorshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 8 months-old In-milk and In-calf Heifer; bred by himself.

LORD BERWICK, of Cronkhill, near Shrewsbury: the Prize of TEN SOVEREIGNS, for his 2 years and 11 months-old In-calf Heifer; bred by himself.

JOHN NAYLOR, of Leighton Hall, near Welshpool, Montgomeryshire: the Prize of FIVE SOVEREIGNS, for his 2 years and 11 months-old In-calf Heifer; bred by himself.

EDWARD PRICE, of Court House, Pembridge, near Leominster: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 5 months-old Heifer; bred by himself.

REV. ARCHER CLIVE, of Whitfield, near Hereford: the Prize of TEN SOVEREIGNS, for his 1 year and 11 months-old Heifer; bred by himself.

EDMUND WRIGHT, of Halston Hall, near Oswestry: the Prize of FIVE SOVEREIGNS, for his 1 year and 11 months-old Heifer; bred by himself.

CATTLE: *Devons.*

WALTER FARTHING, of Stowey Court, near Bridgewater, Somerset: the Prize of THIRTY SOVEREIGNS, for his 2 years and 6 months-old Bull: bred by Sir A. A. Hood, Bart., M.P., of St. Audries, near Taunton.

JOHN QUARTLY, of Molland, near Southmolton, Devon: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 3 months-old Bull; bred by himself.

THOMAS WHITE FOURACRE, of Durston, near Taunton, Somerset: the Prize of FIVE SOVEREIGNS, for his 5 years and 4 months-old Bull; bred by John Bodley, of Stockley Pomeroy, near Crediton.

JOHN QUARTLY, of Molland, near Southmolton, Devon: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year and 2 months-old Bull; bred by himself.

HIS ROYAL HIGHNESS THE PRINCE CONSORT: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 9 months-old Bull; bred by himself.

WILLIAM HOLE, of Hannaford, near Barnstaple, Devon: the Prize of FIVE SOVEREIGNS, for his 1 year and 9 months-old Bull; bred by himself.

WILLIAM HOLE, of Hannaford, near Barnstaple, Devon: the Prize of TEN SOVEREIGNS, for his 8 months-old Bull-Calf; bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of FIVE SOVEREIGNS, for his 7 months-old Bull-Calf; bred by himself.

JAMES MERSON, of Brinsworthy, near North Molton, Devon: the Prize of TWENTY SOVEREIGNS, for his 6 years and 9 months-old In-milk and In-calf Cow; bred by himself.

WALTER FARTHING, of Stowey Court, near Bridgewater, Somerset: the Prize of TEN SOVEREIGNS, for his 4 years and 3 months-old In-milk and In-calf Cow; bred by himself.

JAMES QUARTLY, of Molland House, near Southmolton, Devon: the Prize of FIVE SOVEREIGNS, for his 7 years and 6 months-old In-milk and In-calf Cow; bred by himself.

JAMES QUARTLY, of Molland House, near Southmolton, Devon: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 6 months-old In-calf Heifer; bred by himself.

GEORGE TURNER, of Barton, near Exeter: the Prize of TEN SOVEREIGNS, for his 2 years and 8 months-old In-calf Heifer; bred by himself.

EDWARD POPE, of Great Toller, near Maiden Newton, Dorset: the Prize of FIVE SOVEREIGNS, for his 2 years and 5 months-old In-calf Heifer; bred by himself.

JOHN QUARTLY, of Molland, near Southmolton, Devon: the Prize of FIFTEEN SOVEREIGNS, for his 1 year and 6 months-old Heifer; bred by himself.

HIS ROYAL HIGHNESS THE PRINCE CONSORT: the Prize of TEN SOVEREIGNS, for his 1 year and 10 months-old Heifer; bred by himself.

JOHN MILDON, of Woodington Farm, near Witheridge, Devon: the Prize of FIVE SOVEREIGNS, for his 1 year and 11 months-old Heifer; bred by himself.

CATTLE: *Other established Breeds.*

HON. COLONEL PENNANT, M.P., of Penrhyn Castle, near Bangor, Carnarvon, the Prize of TEN SOVEREIGNS, for his 4 years and 2 months-old Bull; bred by William Owen, of Tai Cochion, near Carnarvon.

JOHN TURVILLE, of Hartley Park, near Alton, Hants: the Prize of TEN SOVEREIGNS, for his 1 year and 11 months-old Jersey Bull; bred by Edward Chalcraft, of Liphook, Hants.

EARL OF SOUTHESK, of Kinnaird Castle, near Brechin, Forfar: the Prize of TEN SOVEREIGNS, for his 3 years and 10 months-old polled Angus In-milk and In-calf Cow; bred by himself.

LORD SONDES, of Elmham Hall, near Thetford, Norfolk: the Prize of TEN SOVEREIGNS, for his 2 years and 1 month-old Norfolk polled In-calf Heifer; bred by himself.

EARL OF SOUTHESK, of Kinnaird Castle, near Brechin, Forfarshire: the Prize of FIVE SOVEREIGNS, for his 1 year and 2 months-old polled Angus Heifer; bred by himself.

HORSES.

JOHN HEMMANT, of Thorney Fen, near Peterborough: the Prize of TWENTY-FIVE SOVEREIGNS, for his 4 years and 1 month-old Agricultural Stallion; bred by Mr. Gedney, of Cowbit, near Spalding.

SAMUEL CLAYDEN, of Linton, Cambridge: the Prize of FIFTEEN SOVEREIGNS, for his 4 years and 2 months-old Suffolk Agricultural Stallion; bred by himself.

HENRY HITCHCOCK, of Chittern All Saints, near Heytesbury, Wilts: the Prize of FIVE SOVEREIGNS, for his 3 years and 1 month-old Warwick and Suffolk Agricultural Stallion; bred by William Lavington, of Chittern St. Mary, near Heytesbury.

EDWARD HOLLAND, M.P., of Dumbleton Hall, near Evesham: the Prize of TWENTY SOVEREIGNS, for his 2 years and 1 month-old Agricultural Stallion; bred by himself.

ROBERT HENRY WRINCH, of Harkstead, near Ipswich, Suffolk: the Prize of TEN SOVEREIGNS, for his 2 years-old Suffolk Agricultural Stallion; bred by Samuel Wrinch, of Great Holland, near Colchester.

CHARLES FROST, of Wherstead, near Ipswich, Suffolk: the Prize of TWENTY SOVEREIGNS, for his 6 years-old Suffolk Agricultural Mare with her foal; bred by himself.

G. D. BADHAM, of Bulmer, near Sudbury, Suffolk: the Prize of TEN SOVEREIGNS, for his 4 years-old Suffolk Agricultural Mare with her foal; bred by himself.

LEONARD WRINCH, of Arwarton, near Ipswich, Suffolk: the Prize of FIFTEEN SOVEREIGNS, for his 2 years-old Suffolk Agricultural Filly; bred by himself.

HIS ROYAL HIGHNESS THE PRINCE CONSORT: the Prize of TEN SOVEREIGNS, for his 2 years and 1 month-old Clydesdale Agricultural Filly; bred by himself.

BENJAMIN TAYLOR, of New Road, Peterborough: the Prize of TWENTY-FIVE SOVEREIGNS, for his 8 years-old Dray Stallion; bred by the late John Woolsey, of Newton, near Wisbeach.

JOHN HEMMANT, of Thorney Fen, near Peterborough: the Prize of TEN SOVEREIGNS, for his 13 years and 1 month-old Dray Stallion; bred by Mr. Laxton, of March, Cambridge.

THOMAS HIBBARD, of Bishopstone, near Faringdon, Berks: the Prize of FIFTEEN SOVEREIGNS, for his 2 years and 1 month-old Dray Stallion; bred by Charles Hibbard, of Fernham, near Faringdon.

WILLIAM BULLER, of Hanwell Fields, near Banbury, Oxon: the Prize of FIVE SOVEREIGNS, for his 2 years and 2 months-old Dray Stallion; bred by Stephen Root, of Edgcott Lodge, near Banbury.

WILLIAM LOWRIE, of Cadoxton, near Cardiff, Glamorgan: the Prize of TWENTY SOVEREIGNS, for his 8 years-old Dray Mare with her foal; breeder unknown.

THOMAS RUSSELL, of Hodwell Manor, near Southam, Warwick: the Prize of TEN SOVEREIGNS, for his 2 years-old Dray Filly; bred by himself.

JOHN WADLOW, of Shiffnall, Salop: the Prize of TWENTY-FIVE SOVEREIGNS, for his 5 years-old thorough-bred Stallion for getting hunters; bred by William Sadler, of Doncaster.

WILLIAM BARNETT, of Bays Hill Lawn, near Cheltenham: the Prize of FIFTEEN SOVEREIGNS, for his 15 years-old thorough-bred Stallion for getting hunters; bred by the late Hon. Richard Watson, of Rockingham Castle, Northampton.

CHARLES AIKIN HOLLAND, of Hartford Hill, near Northwich, Cheshire: the Prize of TWENTY SOVEREIGNS, for his 6 years-old Mare for breeding hunters; breeder unknown.

WILLIAM SHAW, of Far Coton, Northampton: the Prize of TEN SOVEREIGNS, for his 16 years-old Mare for breeding hunters, with her foal; bred by himself.

WALTER COLEMAN, of Kingsbury Hall, near Tamworth: the Prize of FIFTEEN SOVEREIGNS, for his aged Mare for breeding hackneys; breeder unknown.

SAMUEL WALLIS, of Barton Seagrave, near Kettering: the Prize of FIVE SOVEREIGNS, for his 17 years-old Mare for breeding hackneys; bred by himself.

SHEEP: *Leicesters.*

WILLIAM SANDAY, of Holme Pierrepont, near Nottingham: the Prize of TWENTY SOVEREIGNS, for his 16 months-old Shearling Ram; bred by himself.

WILLIAM SANDAY, of Holme Pierrepont, near Nottingham: the Prize of TEN SOVEREIGNS, for his 16 months-old Shearling Ram; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Five Sovereigns, for his 16 months-old Shearling Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Sandy, Beds: the Prize of Twenty Sovereigns, for his 2 years and 4 months-old Ram; bred by himself.

Thomas Edward Pawlett, of Beeston, near Sandy, Beds: the Prize of Ten Sovereigns, for his 2 years and 4 months-old Ram; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Five Sovereigns, for his 4 years and 4 months-old Ram; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Twenty Sovereigns, for his 16 months-old Pen of five Shearling Ewes; bred by himself.

William Sanday, of Holme Pierrepont, near Nottingham: the Prize of Ten Sovereigns, for his 16 months-old Pen of five Shearling Ewes; bred by himself.

Lieutenant-Colonel Inge, of Thorpe Constantine, near Tamworth: the Prize of Five Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes; bred by himself.

Sheep: *Southdowns.*

Duke of Richmond, of Goodwood, near Chichester, Sussex: the Prize of Twenty Sovereigns, for his 1 year and 4 months-old Shearling Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Shearling Ram; bred by himself.

Jonas Webb, of Babraham, near Cambridge: the Prize of Five Sovereigns, for his 1 year and 4 months-old Shearling Ram; bred by himself.

Duke of Richmond, of Goodwood, near Chichester, Sussex: the Prize of Twenty Sovereigns, for his 3 years and 4 months-old Ram; bred by himself.

William Rigden, of Hove, near Brighton: the Prize of Ten Sovereigns, for his 2 years and 4 months-old Ram; bred by himself.

William Rigden, of Hove, near Brighton: the Prize of Five Sovereigns, for his 2 years and 4 months-old Ram; bred by himself.

Duke of Richmond, of Goodwood, near Chichester, Sussex: the Prize of Twenty Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes; bred by himself.

Duke of Richmond, of Goodwood, near Chichester, Sussex: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes; bred by himself.

William Rigden, of Hove, near Brighton: the Prize of Five Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes; bred by himself.

Sheep: *Long-woolled (not Leicesters).*

Robert Garne, of Aldsworth, near Northleach, Gloucestershire: the Prize of Twenty Sovereigns, for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

Robert Garne, of Aldsworth, near Northleach: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Shearling Cotswold Ram; bred by himself.

George Fletcher, of Shipton Sollars, near Cheltenham: the Prize of Five Sovereigns, for his 1 year and 3 months-old Shearling Cotswold Ram; bred by himself.

THOMAS PORTER, of Baunton, near Cirencester: the Prize of TWENTY SOVEREIGNS, for his 3 years and 4 months-old Cotswold Ram; bred by himself.

ROBERT GARNE, of Aldsworth, near Northleach: the Prize of TEN SOVEREIGNS, for his 2 years and 4 months-old Cotswold Ram; bred by the late William Garne, of Aldsworth.

GEORGE FLETCHER, of Shipton Sollars, near Cheltenham: the Prize of FIVE SOVEREIGNS, for his 4 years and 3 months-old Cotswold Ram; bred by himself.

THOMAS WALKER, of Yanworth, near Northleach: the Prize of TWENTY SOVEREIGNS, for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

WILLIAM LANE, of Broadfield Farm, near Northleach: the Prize of TEN SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

GEORGE FLETCHER, of Shipton Sollars, near Cheltenham: the Prize of FIVE SOVEREIGNS, for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

SHEEP: *Short-woolled (not Southdowns).*

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage: the Prize of TWENTY SOVEREIGNS, for his 1 year and 5 months-old Shearling West Country Down Ram; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage: the Prize of TEN SOVEREIGNS, for his 1 year and 4 months-old Shearling West Country Down Ram; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage: the Prize of FIVE SOVEREIGNS, for his 1 year and 5 months-old Shearling Ram; bred by the Earl of Portsmouth, of Hurstbourne Park, near Whitchurch, Hants.

SAMUEL DRUCE, of Eynsham, near Oxford: the Prize of TWENTY SOVEREIGNS, for his 2 years and 5 months-old Oxfordshire Down Ram; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage: the Prize of TEN SOVEREIGNS, for his 3 years and 4 months-old West Country Down Ram; bred by himself.

GEORGE ADNEY, of Harley, near Much-Wenlock, Salop: the Prize of FIVE SOVEREIGNS, for his 2 years and 3 months-old Shropshire Down Ram; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage: the Prize of TWENTY SOVEREIGNS, for his 1 year and 5 months-old Pen of five Shearling West Country Down Ewes; bred by himself.

STEPHEN KING, of Old Hayward Farm, near Hungerford, Berks: the Prize of TEN SOVEREIGNS, for his 1 year and 4 months-old Pen of five Shearling West Country Down Ewes; bred by himself.

WILLIAM BROWNE CANNING, of Chisledon, near Swindon, Wilts: the Prize of FIVE SOVEREIGNS, for his 1 year and 4 months-old Pen of Improved Hampshire Down Shearling Ewes; bred by himself.

PIGS.

JOHN HARRISON, jun., of Heaton-Norris, near Stockport: the Prize of TEN SOVEREIGNS, for his 1 year and 11 months-old large-breed Boar; bred by himself.

JOHN WOODCOCK, of Netherhampton, near Salisbury: the Prize of FIVE SOVEREIGNS, for his 6 months-old large-breed Berkshire Boar; bred by himself.

Michael Gavins, of the Fox Inn, Woodhouse Carr, near Leeds: the Prize of Three Sovereigns, for his 1 year and 10 months-old large-breed Improved Yorkshire Boar; bred by himself.

His Royal Highness the Prince Consort: the Prize of Ten Sovereigns, for his 2 years and 9 months-old small-breed Windsor Boar; bred by himself.

Thomas Crisp, of Butley Abbey, near Wickham Market: the Prize of Five Sovereigns, for his 1 year and 9 months-old small-breed Suffolk Boar; bred by himself.

John Holdway, of Weston, near Bath: the Prize of Three Sovereigns, for his 1 year and 7 months-old small-breed Essex Boar; bred by himself.

Sir R. G. Throckmorton, Bart., of Buckland, near Faringdon, Berks: the Prize of Ten Sovereigns, for his 2 years and 7 months-old large-breed Berkshire Sow; bred by himself.

William B. Wainman, of Carhead, near Cross Hills, York: the Prize of Five Sovereigns, for his 1 year and 4 months-old large-breed Carhead Sow; bred by himself.

John Woodcock, of Netherhampton, near Salisbury: the Prize of Three Sovereigns, for his 2 years-old large-breed Berkshire Sow; bred by himself.

Thomas Crisp, of Butley Abbey, near Wickham Market, Suffolk: the Prize of Ten Sovereigns, for his 2 years-old small-breed Sow; bred by himself.

George Turner, of Barton, near Exeter: the Prize of Five Sovereigns, for his 1 year and 8 months-old small-breed Improved Essex Sow; bred by himself.

Thomas Crisp, of Butley Abbey, near Wickham Market, Suffolk: the Prize of Three Sovereigns, for his 4 years-old small-breed Sow; bred by himself.

George B. Morland, of Chilton Farm, near Harwell, Berks: the Prize of Ten Sovereigns, for his three 7 months-old large-breed Improved Chilton Sow-pigs; bred by himself.

William James Sadler, of Bentham Calcutt, near Cricklade, Wilts: the Prize of Five Sovereigns, for his three 6 months-old large-breed Berkshire Sow-pigs; bred by himself.

His Royal Highness the Prince Consort: the Prize of Ten Sovereigns, for his three 7 months-old small-breed Windsor Sow-pigs; bred by himself.

Robert H. Watson, of Bolton Park, near Wigton, Cumberland: the Prize of Five Sovereigns, for his three 7 months-old small-breed Sow-pigs; bred by himself.

Special Prizes,

GIVEN BY THE WARWICK LOCAL COMMITTEE.

Cattle: *best adapted for Dairy purposes.*

Henry Ambler, of Watkinson Hall Farm, near Halifax: the Prize of Twenty Sovereigns, for his 1 year and 2 months-old Short-horned Bull; bred by himself.

John Kay Farnworth, of The Oak Farm, Alderley Edge, near Chorley: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Short-horned Bull; bred by Willoughby Wood, of Holly Bank, Burton-upon-Trent, Staffordshire.

Lord Feversham, of Duncombe Park, near Helmsley, York: the Prize of Five Sovereigns, for his 1 year and 5 months-old Short-horned Bull; bred by himself.

J. H. LANGSTON, M.P., of Sarsden House, near Chipping Norton : the Prize of TWENTY SOVEREIGNS, for his 10 years and 7 months-old Short-horned In-milk and In-calf Cow, and his 11 years and 2 months-old Short-horned In-milk and In-calf Cow ; both bred by himself.

HON. COLONEL PENNANT, M.P., of Penrhyn Castle, near Bangor : the Prize of TEN SOVEREIGNS, for his 11 years and 6 months-old Short-horned In-calf and In-milk Cow, and his 10 years-old Short-horned In-calf and In-milk Cow ; both bred by A. Cruickshank, of Sittyton, near Aberdeen.

EDMUND LYTHALL, of Radford Hall, near Leamington, Warwickshire : the Prize of FIVE SOVEREIGNS, for his 6 years and 2 months-old Short-horned In-calf Cow ; bred by George Horn, of Sidney Terrace, near Leamington : and his 6 years and 1 month-old Short-horned In-calf Cow ; bred by himself.

JOSHUA PRICE, of Featherstone, near Wolverhampton : the Prize of TWENTY SOVEREIGNS, for his 2 years and 2 months-old Short-horned In-calf Heifer, and his 2 years and 1 month-old Short-horned In-calf Heifer ; both bred by himself.

JOHN HUTT, of Water Eaton, near Oxford : the Prize of TEN SOVEREIGNS for his 1 year and 11 months-old Short-horned In-calf Heifer, and his 2 years and 1 month-old Short-horned In-calf Heifer ; both bred by himself.

JOHN KING TOMBS, of Langford, near Lechlade, Gloucestershire : the Prize of FIVE SOVEREIGNS, for his 2 years and 4 months-old Short-horned In-calf Heifer, and his 2 years and 4 months-old Short-horned In-calf Heifer ; both bred by himself.

HENRY AMBLER, of Watkinson Hall, near Halifax : the Prize of TWENTY SOVEREIGNS, for his 1 year and 4 months-old Short-horned Heifer, and his 1 year and 4 months-old Short-horned Heifer ; both bred by himself.

HON. COLONEL PENNANT, M.P., of Penrhyn Castle, near Bangor : the Prize of TEN SOVEREIGNS, for his 1 year and 9 months-old Short-horned Heifer, and his 1 year and 8 months-old Short-horned Heifer ; both bred by himself.

WILLIAM FLETCHER, of Radmanthwaite, near Mansfield, Notts : the Prize of FIVE SOVEREIGNS, for his 1 year and 5 months-old Short-horned Heifer, and his 1 year and 3 months-old Short-horned Heifer ; both bred by himself.

CATTLE : *Pure Long-horns.*

JOSH. HOLLAND BURBERY, of The Chase, near Kenilworth, Warwick : the Prize of TEN SOVEREIGNS, for his 5 years and 3 months-old Bull ; bred by the late S. Burbury, of Wroxhall, Warwick.

MICHAEL TAVERNER, of Upton, near Nuneaton, Warwick : the Prize of FIVE SOVEREIGNS, for his 4 years and 3 months-old Bull ; bred by R. H. Chapman, of Upton.

LIEUTENANT-COLONEL INGE, of Thorpe Constantine, near Tamworth, Staffordshire : the Prize of TEN SOVEREIGNS, for his 9 years and 6 months-old In-calf Cow ; and his 7 years and 7 months-old In-milk and In-calf Cow ; both bred by himself.

JOHN GODFREY, of Wigston Parva, near Nuneaton : the Prize of FIVE SOVEREIGNS, for his 6 years-old In-milk and In-calf Cow, and his 6 years-old In-calf Cow ; both bred by himself.

HORSES.

JOHN MANNING, of Orlingbury, near Wellingborough, Northamptonshire : the Prize of TWENTY SOVEREIGNS, for his 6 years-old Agricultural Northamptonshire Stallion ; bred by Mr. Ogden, of Ashton, near Stamford.

Robert Spencer, of Shuckburgh Lodge, near Daventry: the Prize of Ten Sovereigns, for his 5 years and 1 month-old Agricultural Warwickshire Stallion; bred by Mr. Robert Cowley, of Kilsby, near Rugby.

William Buller, of Hanwell Fields, near Banbury, Oxon: the Prize of Fifteen Sovereigns, for his 2 years-old Agricultural Oxfordshire Stallion; bred by George Griffin, jun., of Farnborough Fields, near Banbury.

Thomas Crisp, of Butley Abbey, near Wickham Market, Suffolk: the Prize of Five Sovereigns, for his 2 years-old Agricultural Suffolk Stallion; bred by himself.

John Gay Attwater, of Hallingwood Farm, Cubberley, near Cheltenham and Gloucester: the Prize of Ten Sovereigns, for his 3 years and 2 months-old Agricultural Mare, and his 3 years and 2 months-old Agricultural Mare; both bred by himself.

John Beasley, of Chapel Brampton, near Northampton: the Prize of Five Sovereigns, for his 7 years-old Agricultural Suffolk Gelding, and his 8 years-old Agricultural Suffolk Gelding; both bred by himself.

William Lowrie, of Cadoxton, near Cardiff: the Prize of Ten Sovereigns, for his 1 year and 1 month-old Agricultural Filly; bred by himself.

Walter Coleman, of Kingsbury Hall, near Tamworth: the Prize of Twenty Sovereigns, for his 4 years-old Hunting Gelding; bred by himself.

Lord Berners, of Keythorpe Hall, near Leicester: the Prize of Ten Sovereigns, for his 11 years-old Hunting Mare; bred by himself.

Sir Pyers Mostyn, Bart., of Talacre, near Rhyl, Flintshire: the Prize of Ten Sovereigns, for his 11 years-old Talacre Pony Stallion; bred by himself.

James Cresswell Wall, of Redland Lodge, near Bristol: the Prize of Five Sovereigns, for his 14 years-old Welsh Pony Stallion; breeder unknown.

Shropshire Sheep.

John Coxon, of Freeford Farm, near Lichfield, Staffordshire: the Prize of Twenty Sovereigns, for his 1 year and 3 months-old Shearling Ram; bred by himself.

Henry Sheldon, of Braile's House, near Shipston-on-Stour: the Prize of Ten Sovereigns, for his 1 year and 3 months-old Shearling Ram; bred by himself.

Thomas Horley, Jun., of The Fosse, near Leamington: the Prize of Five Sovereigns, for his 1 year and 4 months-old Shearling Ram; bred by himself.

Mrs. Baker, of Grendon, near Atherstone, Warwick: the Prize of Twenty Sovereigns, for her 2 years and 3 months-old Ram; bred by herself.

James and Edward Crane, of Sharwardine, near Shrewsbury: the Prize of Ten Sovereigns, for their 2 years and 3 months-old Ram; bred by themselves.

George Adney, of Harley, near Much-Wenlock: the Prize of Five Sovereigns, for his 3 years and 3 months-old Ram; bred by himself.

Edward Holland, M.P., of Dumbleton Hall, near Evesham: the Prize of Fifteen Sovereigns, for his 1 year and 3 months-old Pen of five Theaves; bred by himself.

James and Edward Crane, of Sharwardine, near Shrewsbury: the Prize of Five Sovereigns, for their 1 year and 3 months-old Pen of five Theaves; bred by themselves.

Pigs.

William Hewer, of Sevenhampton, near Highworth, Wilts: the Prize of Ten Sovereigns, for his 1 year and 7 months-old Berkshire Boar; bred by himself.

EDWARD BOWLY, of Siddington House, near Cirencester: the Prize of FIVE SOVEREIGNS, for his 1 year and 1 month-old Improved Berkshire Boar; bred by himself.

WILLIAM HEWER, of Sevenhampton, near Highworth, Wilts: the Prize of TEN SOVEREIGNS, for his 3 years and 7 months-old Berkshire Sow; bred by himself.

WILLIAM JAMES SADLER, of Bentham Calcutt, near Cricklade, Wilts: the Prize of FIVE SOVEREIGNS, for his 1 year and 3 months-old Berkshire Sow; bred by himself.

JOSEPH SMITH, of Henley-in-Arden, Warwick: the Prize of FIFTEEN SOVEREIGNS, for his 4 months -old Pen of five Berkshire Breeding-Pigs; bred by himself.

JOSEPH SMITH, of Henley-in-Arden, Warwick: the Prize of TEN SOVEREIGNS, for his 4 months-old Pen of five Berkshire Breeding-Pigs; bred by himself.

WILLIAM B. WAINMAN, of Carhead, near Cross Hills, York: the Prize of FIFTEEN SOVEREIGNS, for his 4 months-old Pen of five large Carhead Breeding-Pigs; bred by himself.

HON. COLONEL PENNANT, M.P., of Penrhyn Castle, near Bangor: the Prize of FIFTEEN SOVEREIGNS, for his 4 months-old Pen of five small Breeding-Pigs; bred by himself.

ROBERT H. WATSON, of Bolton Park, near Wigton, Cumberland: the Prize of TEN SOVEREIGNS, for his 4 months-old Pen of five small Breeding-Pigs; bred by himself.

Commendations.

The mark * signifies "SPECIALLY COMMENDED;" the mark † "HIGHLY COMMENDED;" the mark ‡ "COMMENDED" (distinctly and individually), the mark ‖ "HIGHLY COMMENDED" (as part of a whole class); and the omission of these marks, "GENERALLY COMMENDED" (as part of a whole class).

CATTLE.

†VISCOUNT HILL, of Hawkstone, near Shrewsbury: for his 2 years and 10 months-old Short-horned Bull; bred by himself.

†JOHN T. NOAKES, of Brockley House, near Lewisham, Kent: for his 3 years and 3 months-old Short-horned Bull; bred by His Royal Highness the Prince Consort.

‡LORD FEVERSHAM, of Duncombe Park, near Helmsley, York: for his 3 years and 2 months-old Short-horned Bull; bred by himself.

‡MISS E. BARROBY, of Dishforth, near Thirsk: for her 4 years and 10 months-old Short-horned Bull; bred by the late Mark Barroby, of Dishforth.

‡WILLIAM TOD, of Elphinstone Tower, near Tranent, Haddingtonshire: for his 3 years and 11 months-old Short-horned Bull; bred by Mark Stewart, of Southwick, near Dumfries.

‡SIR C. R. TEMPEST, Bart., of Broughton Hall, near Skipton: for his 3 years and 3 months-old Short-horned Bull; bred by Mr. Unthank, of Netherscales, near Penrith.

‡JONAS WEBB, of Babraham, near Cambridge: for his 2 years and 4 months-old Short-horned Bull; bred by himself.

†JOHN ARMSTRONG, of Palterton, near Chesterfield: for his 1 year and 10 months-old Short-horned Bull; bred by himself.

‡JOHN HALL, of Kiveton Park, near Worksop: for his 1 year and 3 months-old Short-horned Bull; bred by himself.

‡The Rev. CHARLES WILLIAM HOLBECH, of Farnborough, near Banbury: for his 1 year-old Short-horned Bull; bred by himself.

‡JAMES H. LANGSTON, M.P., of Sarsden House, near Chipping Norton, Oxon: for his 1 year and 5 months-old Short-horned Bull; bred by himself.

†RICHARD STRATTON, of Broad Hinton, near Swindon, Wilts: for his 11 months-old Short-horned Bull-Calf; bred by himself.

†LIEUTENANT-COLONEL TOWNELEY, of Towneley Park, near Burnley: for his 10 months-old Short-horned Bull-Calf; bred by himself.

†RICHARD STRATTON, of Broad Hinton, Swindon: for his 11 months-old Short-horned Bull-Calf: bred by himself.

‡WILLIAM WELLS, of Redleaf, near Penshurst, Kent: for his 10 months-old Short-horned Bull-Calf; bred by James Douglas, of Athelstaneford Farm, near Drem.

†JOHN HUTT, of Water Eaton, near Oxford: for his 3 years and 4 months-old In-milk and In-calf Short-horned Cow; bred by himself.

‡The HON. COLONEL PENNANT, M.P., of Penrhyn Castle, near Bangor: for his 6 years and 2 months-old In-calf Short-horned Cow; bred by W. Harrison, of Close House, near Darlington.

‡JOHN ARMSTRONG, of Palterton, near Chesterfield: for his 3 years and 1 month-old In-milk and In-calf Short-horned Cow; bred by himself.

†HENRY AMBLER, of Watkinson Hall Farm, near Halifax: for his 3 years and 9 months-old In-milk and In-calf Short-horned Cow; bred by himself; and his 9 years and 7 months-old In-milk and In-calf Short-horned Cow; bred by F. H. Fawkes, of Farnley Hall, near Otley.

‡HENRY RAWLINS, of Ashorne, near Leamington, Warwick: for his 7 years and 4 months-old Short-horned Cow; and his 7 years and 3 months-old Short-horned Cow; both bred by himself.

‡EDWARD BOWLY, of Siddington House, near Cirencester: for his 6 years and 1 month-old Short-horned Cow, and his 3 years and 1 month-old Short-horned Cow; both In-milk and In-calf; bred by himself.

†LIEUTENANT-COLONEL TOWNELEY, of Towneley Park, near Burnley, Lancaster: for his 2 years and 11 months-old In-milk Short-horned Heifer; bred by himself.

†STEWART MAJORIBANKS, of Bushey Grove, near Watford, Herts: for his 2 years and 11 months-old In-milk and In-calf Short-horned Heifer; bred by Thos. Robson, of Holtby House, near Catterick, York.

†JAMES DOUGLAS, of Athelstaneford Farm, near Drem, Haddingtonshire: for his 2 years and 3 months-old In-calf Short-horned Heifer; bred by himself.

‡STEWART MAJORIBANKS, of Bushey Grove, near Watford, Herts: for his 2 years and 7 months-old In-calf Short-horned Heifer; bred by William Smith, of West Rasen, near Market Rasen.

‡CAPTAIN GUNTER, of the Grange, near Wetherby, Yorkshire: for his 2 years and 3 months-old In-calf Short-horned Heifer; bred by himself.

‡EDWARD BOWLY, of Siddington House, near Cirencester: for his 2 years and 3 months-old In-calf Short-horned Heifer; bred by himself.

COLONEL THE HON. O. DUNCOMBE, of Waresley Park, near St. Neot's, Huntingdonshire; for his 2 years and 6 months-old In-calf Short-horned Heifer; bred by himself.

COLONEL THE HON. O. DUNCOMBE, of Waresley Park, near St. Neot's: for his 2 years and 5 months-old In-calf Short-horned Heifer; bred by himself.

CAPTAIN GUNTER, of The Grange, near Wetherby: for his 2 years and 4 months-old In-calf Short-horned Heifer; bred by himself.

EARL SPENCER, of Althorp, near Northampton: for his 2 years and 2 months-old In-calf Short-horned Heifer; bred by himself.

RICHARD BOOTH, of Warlaby. near Northallerton: for his 2 years and 6 months old In-calf Short-horned Heifer; bred by himself.

SIR CHARLES R. TEMPEST, BART., of Broughton Hall, near Skipton, Yorkshire: for his 2 years and 7 months-old In-calf Short-horned Heifer; bred by himself.

†JOHN GRUNDY, of the Dales, Stand, near Manchester: for his 1 year and 10 months-old Short-horned Heifer; bred by himself.

†RICHARD STRATTON, of Broad Hinton, near Swindon, Wilts: for his 1 year and 7 months-old Short-horned Heifer; bred by himself.

†THE HON. AND REV. T. H. NOEL HILL, of Berrington, near Shrewsbury: for his 1 year and 10 months-old Short-horned Heifer; bred by himself.

†LIEUTENANT-COLONEL TOWNELEY, of Towneley Park, near Burnley: for his 1 year and 4 months-old Short-horned Heifer; bred by himself.

†JONAS WEBB, of Babraham, near Cambridge: for his 1 year and 11 months-old Short-horned Heifer; bred by himself.

‡RICHARD STRATTON, of Broad Hinton, near Swindon, Wilts: for his 1 year and 11 months-old Short-horned Heifer; bred by himself.

CHARLES CLINCH, of Church Green, near Witney, Oxon: for his 1 year and 7 months-old Short-horned Heifer; bred by Mr. Middleton, of Cutteslowe, near Oxford.

VISCOUNT DILLON, of Dytchley, near Enstone, Oxon: for his 1 year and 1 month-old Short-horned Heifer; bred by himself.

STEWART MAJORIBANKS, of Bushey Grove, near Watford, Herts: for his 1 year and 11 months-old In-calf Short-horned Heifer; bred by himself.

STEWART MAJORIBANKS, of Bushey Grove, near Watford, Herts: for his 1 year and 1 month-old Short-horned Heifer; bred by himself.

JOSHUA PRICE, of Featherstone, near Wolverhampton, Staffordshire: for his 1 year and 5 months-old Short-horned Heifer; bred by himself.

JOSHUA PRICE, of Featherstone, near Wolverhampton, Staffordshire: for his 1 year and 1 month-old Short-horn Heifer; bred by himself.

JAMES DOUGLAS, of Athelstaneford Farm, near Drem, Haddington: for his 1 year and 2 months-old Short-horned Heifer; bred by himself.

THE ROYAL AGRICULTURAL COLLEGE FARM, Cirencester: for a 1 year and 5 months-old Short-horned Heifer; bred at the Royal Agricultural College.

THE ROYAL AGRICULTURAL COLLEGE FARM, Cirencester: for a 1 year and 4 months-old Short-horned Heifer; bred at the Royal Agricultural College.

WILLIAM BARKER COX, of Pickering: for his 1 year and 7 months-old Short-horned Heifer; bred by Christopher Barnett, of Ainderby, near Northallerton.

JOSEPH ROBINSON, of Clifton Pastures, near Newport Pagnell: for his 1 year and 9 months-old Short-horned Heifer; bred by himself.

THE EARL OF RADNOR, of Coleshill House, near Highworth, Wilts: for his 1 year and 8 months-old Short-horned Heifer; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: for his 1 year and 2 months-old Short-horned Heifer; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton: for his 1 year and 9 months-old Short-horned Heifer; bred by himself.

EDWARD BOWLY, of Siddington House, near Cirencester: for his 1 year and 2 months-old Short-horned Heifer; bred by himself.

JOHN HALL, of Kiveton Park, near Worksop: for his 1 year and 8 months-old Short-horned Heifer; bred by himself.

SIR CHARLES R. TEMPEST, BART., of Broughton Hall, near Skipton: for his 1 year and 7 months-old Short-horned Heifer; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: for his 1 year and 8 months-old Short-horned Heifer; bred by himself.

JONAS WEBB, of Babraham, near Cambridge: for his 1 year and 9 months-old Short-horned Heifer; bred by himself.

†JOHN LANE, of Barton Mills, near Cirencester, for his 2 years and 5 months-old Short-horned Heifer, and his 1 year and 11 months-old Short-horned Heifer; both In-calf; bred by himself.

†J. H. LANGSTON, M.P., of Sarsden House, near Chipping Norton, Oxon: for his 2 years and 5 months-old In-calf Short-horned Heifer; bred by himself; and his 2 years and 5 months-old In-calf Short-horn Heifer; bred by himself.

‡JOHN HUTT, of Water Eaton, near Oxford: for his pair of 2 years and 9 months-old In-Calf Short-horned Heifers; bred by himself.

‡WILLIAM WOODWARD, of Northway House, Ashchurch, near Tewkesbury: for his 2 years-old In-calf Short-horned Heifer, and his 1 year and 11 months-old In-calf Short-horned Heifer; bred by himself.

†RICHARD STRATTON, of Broad Hinton, near Swindon, Wilts: for his 1 year and 6 months-old Short-horned Heifer, and his 1 year and 5 months-old Short-horned Heifer; bred by himself.

‡HIS ROYAL HIGHNESS THE PRINCE CONSORT: for his 2 years and 9 months-old Hereford Bull; bred by himself.

‡JOHN NAYLOR, of Leighton Hall, near Welshpool, Montgomeryshire: for his 2 years and 10 months-old Hereford Bull; bred by himself

†Lord Berwick, of Cronkill, near Shrewsbury: for his 11 months-old Hereford Bull-Calf; bred by himself.

‡Lord Bateman, of Shobdon Court, near Leominster: for his 11 months-old Hereford Bull-Calf; bred by himself.

‡Lord Bateman, of Shobdon Court, near Leominster: for his 10 months-old Hereford Bull-Calf; bred by himself.

‡George Pitt, of Chadnor Court, Dilwyn, near Leominster: for his 3 years and 4 months-old In-milk and In-calf Hereford Cow; bred by himself.

‡George Pitt, of Chadnor Court, Dilwyn, near Leominster: for his 4 years and 6 months-old In-calf Hereford Cow; bred by himself.

‡Philip Turner, of The Leen, Pembridge, near Leominster: for his 4 years and 8 months-old In-milk Hereford Cow; bred by himself.

†Lord Bateman, of Shobdon Court, near Leominster: for his 2 years and 11 months-old In-calf Hereford Heifer; bred by himself.

†Thomas Roberts, of Ivington Bury, near Leominster: for his 2 years and 11 months-old In-calf Hereford Heifer; bred by himself.

†Edward Price, of Court House, Pembridge, near Leominster: for his 1 year and 5 months-old Hereford Heifer; bred by himself.

†Philip Turner, of The Leen, Pembridge, near Leominster: for his 1 year and 10 months-old Hereford Heifer; bred by himself.

‡James Rea, of Monaughty, near Knighton, Radnorshire: for his 1 year and 11 months-old Hereford Heifer; bred by himself.

‡James Merson, of Brinsworthy, near North Molton, Devon: for his 2 years and 4 months-old Devon Bull; bred by himself.

‡Samuel Umbers, of Wappenbury, near Leamington, Warwick: for his 1 year and 4 months-old Devon Bull; bred by himself.

‡Samuel Umbers, of Wappenbury, near Leamington, Warwick: for his 6 months-old Devon Bull-Calf; bred by himself.

†Samuel Umbers, of Wappenbury, near Leamington, Warwick: for his 11 years and 4 months-old In-milk and In-calf Devon Cow; bred by the late Thomas Umbers, of Wappenbury.

†James Hole, of Knowle House, near Dunster, Somerset: for his 2 years and 6 months-old In-calf Devon Heifer; bred by himself.

Samuel Umbers, of Wappenbury, near Leamington, Warwick: for his 2 years and 7 months-old In-calf Devon Heifer; bred by himself.

George Turner, of Barton, near Exeter: for his 2 years and 8 months-old In-calf Devon Heifer; bred by himself.

Abraham Umbers, of Weston House, near Leamington Spa, Warwick: for his 2 years and 4 months-old In-calf Devon Heifer; bred by himself.

†James Quartly, of Molland House, near South Molton, Devon: for his 1 year and 7 months-old Devon Heifer; bred by himself.

His Royal Highness the Prince Consort: for his 1 year and and 10 months-old Devon Heifer; bred by himself.

Edward Pope, of Great Toller, near Maiden Newton, Dorset: for his 1 year and 8 months-old Devon Heifer; bred by himself.

Thomas White Fouracre, of Durston, near Taunton: for his 1 year and 2 months-old Devon Heifer; bred by himself.

Samuel Umbers, of Wappenbury, near Leamington, Warwick: for his 1 year and 5 months-old Devon Heifer; bred by himself.

James Merson, of Brinsworthy, near North Molton, Devon: for his 1 year and 4 months-old Devon Heifer; bred by himself.

†The Earl of Southesk, of Kinnaird Castle, near Brechin, Forfarshire: for his 3 years and 5 months-old polled Angus Bull; bred by William M'Combie, of Tillyfour, near Whitehouse, Aberdeen.

‡His Royal Highness the Prince Consort: for his 4 years and 7 months-old Alderney Bull; bred by Sir John Cathcart, of Cooper's Hill, near Chertsey, Surrey.

‡Lord Sondes, of Elmham Hall, near Thetford, Norfolk: for his 1 year-old Norfolk polled Bull; bred by himself.

†Joseph Heaword, of Woodville Reddish, near Stockport, Lancaster: for his 1 year and 1 month-old Bull; bred by himself.

†Richard Hawkes, of Hemscote, near Wellesbourne, Warwick: for his 5 years

and about 3 months-old In-calf and In-milk Long-horned Cow; bred by the late Samuel Burbery, of Wroxhall, Warwick.

‡The Rev. R. T. Forester, of Elmley Lodge, near Droitwich: for his 4 years and 6 months-old In-calf Alderney Cow; bred by himself.

†Lord Sondes, of Elmham Hall, near Thetford, Norfolk: for his 1 year and 8 months-old Norfolk polled Heifer; bred by himself.

‡Richard Hawkes, of Hunscote, near Wellsbourne, Warwick: for his 2 years and 1 month-old Long-horned Bull; bred by himself.

†E. T. Twycross, of Canley, near Coventry: for his 8 years and 2 months-old In-milk Long-horned Cow, and his 7 years and 3 months-old In-milk Long-horned Cow; both bred by himself.

‡E. T. Twycross, of Canley, near Coventry: for his 8 years and 2 months-old In-milk Long-horned Cow, and his 6 years and 2 months-old In-calf Long-horned Cow; bred by himself.

‡J. H. Burbery, of The Chace, near Kenilworth, Warwick: for his 8 years and 3 months-old Long-horned Cow; and his 8 years and 3 months-old Long-horned Cow; one bred by himself, the other by the late S. Burbery, of Wroxall; both In-calf.

†Joshua Price, of Featherstone, near Wolverhampton, Stafford: for his 3 years and 1 month-old In-milk and In-calf Cow, and his 3 years and 1 month-old In-milk and In-calf Cow; bred by W. F. Fryer, of The Weys, Wolverhampton.

Horses.

†Edward and Matthew Reed, of Beamish Burn, near Chester-le-Street, Durham: for their 3 years-old bay Agricultural Stallion; bred by William Pauk, of Boroughfen, Northampton.

‡John Lowe, of Wheelock, near Sandbach, Cheshire: for his 6 years and 1 month-old Agricultural Stallion; bred by Thomas Lawton, of Astbury, near Congleton.

‡Thomas Crisp, of Butley Abbey, near Wickham Market, Suffolk: for his 9 years-old Suffolk Agricultural Stallion; bred by Charles Cordy, of Trimley, near Ipswich.

‡James Morrell, of Headington Hill, near Oxford: for his 5 years and 1 month-old Clydesdale Agricultural Stallion; bred by James Knox, of Foreside, near Nestaton, Renfrewshire.

‡Thomas Baldwin, of Barnt Green, near Bromsgrove, Worcester: for his 9 years and 1 month-old Agricultural Stallion; bred by himself.

‡Joseph Ball, of Packwood Hall, near Hockley Heath, Warwick: for his 5 years-old Agricultural Stallion; bred by himself.

‡William Wynn, of Cranhill Leys, near Alcester: for his 2 years-old Agricultural Stallion; bred by Thomas Holyoake, of Little Alne, near Alcester.

‡N. G. Barthropp, of Cretingham Rookery, near Wickham Market, Suffolk: for his 9 years-old Suffolk Agricultural Mare; with her foal; bred by himself.

‡John Manning, of Orlingbury, near Wellingborough: for his 2 years-old Leicestershire Dray Stallion; bred by Mr. Dexter, of Hallaton, near Uppingham.

†C. B. and J. W. Robinson, 15, Charlotte-street, Leamington: for their 13 years-old Agricultural Horse, breeder unknown; and their 9 years-old Agricultural Horse; bred by Mr. Walker, of Southam, Warwick.

‡James Dormer, of Ashow, near Kenilworth, Warwick: for his 7 years-old Agricultural Gelding, and his 8 years-old Agricultural Gelding; breeder unknown.

†John B. Booth, of Killerby, near Catterick, Yorkshire: for his 4 years-old Hunting Gelding; bred by the late C. Watson, of Ovington, near Barnard Castle.

†J. T. Arkwright, of Hatton, near Warwick, for his 4 years-old Hunting Gelding; breeder unknown.

†R. F. Formby, of Hasely Hall, near Warwick: for his 5 years-old Hunting Gelding; bred by Thomas Goodcliffe, of Farcet, Cambridge.

RICHARD GREAVES, of The Cliffe, near Warwick: for his 6 years-old bay Hunter; breeder unknown.

SAMUEL BERRY CONGREVE, of Harborough Magna, near Rugby: for his 6 years and 3 months-old Hunting Gelding; bred by himself.

HENRY MIDDLETON, of Cutteslowe, near Oxford: for his 7 years-old Hunting Mare; breeder unknown.

RICHARD BLOXSIDGE, of Summer-place, Salt-lane, near Worcester: for his 5 years-old Hunting Gelding; bred by himself.

EDWARD DAVIES, of Warwick: for his 5 years-old chesnut Hunting Gelding; bred by himself.

WILLIAM TIBBITTS, of Wroxhall, near Warwick: for his 5 years-old Hunting Gelding; bred by the late Samuel Burbery.

WILLIAM NEWSOME, of Milverton crescent, near Leamington Spa, Warwick: for his 7 years-old Hunter; breeder unknown.

DIGBY COLLINS, of Edge Grove, near Shrewsbury: for his 5 years-old Hunting Mare; bred by the late Mr. Mansell, of Longnor Park Farm, near Shrewsbury.

THOMAS ALDER LEE, of Ducklington, near Witney, Oxon: for his 7 years-old Hunting Mare.

JAMES WHITE, of Lindons, near Coleford, Gloucestershire; for his 4 years-old Hunting Mare; bred by himself.

THOMAS H. ENGLAND, of Snitterfield, near Stratford-on-Avon: for his 4 years and 3 months-old Hunting Gelding; bred by Mr. Woodward, of Evesham.

R. F. FORMBY, of Haseley Hall, near Warwick: for his 5 years-old Hunting Gelding.

GEORGE M'CULLOCH, of Pemberton, near Wigan, Lancaster: for his 7 years and 2 months-old Hunting Mare; breeder unknown.

†DENIS SULLIVAN, of 70, Wellington-street, Dublin: for his 9 years-old thorough-bred Pony Stallion "Cupid;" bred by Denis Carton, of 16, Halston-street, Dublin.

†JAMES CRESSWELL WALL, of Redland Lodge, near Bristol: for his 6 years-old Welsh Pony Stallion; bred by Mr. Blakemore, of Monmouth.

EDWARD COOKES, of Warwick: for his 3 years-old Welsh Pony Stallion.

THOMAS CRISP, of Butley Abbey, near Wickham Market, Suffolk: for his 8 years-old Pony Stallion; bred by John Artis, of Sudbourn, near Wickham Market.

THOMAS DUPPA DUPPA, of Longville, near Wistanstow, Salop: for his 4 years-old Mountain Pony Stallion; breeder unknown.

GEORGE MOUSLEY, of Atherstone, Warwick: for his 3 years and 1 month-old thorough-bred Pony Stallion "Spider;" bred by himself.

ROBERT GRIFFITHS, of Cross Keys Inn, Llantrissant, Glamorganshire: for his 8 years and 1 month-old Pony Stallion; bred by David Havard, of Defynnock, near Brecon.

FREDERICK BLAKELY, of Penrhos Court, near Kington, Herefordshire: for his 2 years and 2 months-old Radnor-Forest Pony Stallion; bred by himself.

SHEEP.

†WILLIAM SANDAY, of Holme Pierrepont, near Nottingham: for his 2 years and 4 months-old Leicester Ram; bred by himself.

‡WILLIAM SANDAY, of Holme Pierrepont, near Nottingham: for his 3 years and 4 months-old Leicester Ram; bred by himself.

†THE DUKE OF RICHMOND, of Goodwood, near Chichester: for his 1 year and 4 months-old Southdown Shearling Ram; bred by himself.

†THE DUKE OF RICHMOND, of Goodwood, near Chichester: for his 1 year and 4 months-old Southdown Shearling Ram; bred by himself.

‡WILLIAM RIGDEN, of Hove, near Brighton: for his 1 year and 4 months-old Southdown Shearling Ram; bred by himself.

‡WILLIAM RIGDEN, of Hove, near Brighton: for his 1 year and 4 months-old Southdown Shearling Ram; bred by himself.

‡JONAS WEBB, of Babraham, near Cambridge: for his 1 year and 4 months-old Southdown Shearling Ram; bred by himself.

†SIR R. G. THROCKMORTON, BART., of Buckland, near Faringdon, Berks: for his 2 years and 4 months-old Southdown Ram; bred by himself.

‡William Rigden, of Hove, near Brighton: for his 3 years and 4 months-old Southdown Ram; bred by himself.

†Sir R. G. Throckmorton, Bart., of Buckland, near Faringdon, Berks: for his 1 year and 4 months-old Pen of five Southdown Shearling Ewes; bred by himself.

‡The Duke of Beaufort, of Badminton, near Chippenham, Wilts: for his 1 year and 3 months-old Pen of five Southdown Shearling Ewes; bred by himself.

†Robert Garne, of Aldsworth, near Northleach, Gloucestershire: for his 1 year and 4 months-old Cotswold Ram; bred by himself.

†James Walker, of Northleach: for his 1 year and 4 months-old Cotswold Ram; bred by himself.

†John Gillett, of Minster Lovell, near Witney, Oxon: for his 1 year and 3 months-old Cotswold Ram; bred by himself.

‡George Fletcher, of Shipton Sollars, near Cheltenham: for his 15 months-old Cotswold Ram; bred by himself.

‡George Fletcher, of Shipton Sollars, near Cheltenham: for his 15 months-old Cotswold Ram; bred by himself.

‡Edward Handy, of Sierford, near Cheltenham: for his 1 year and 3 months-old Cotswold Ram; bred by himself.

‡Edward Handy, of Sierford, near Cheltenham: for his 1 year and 3 months-old Cotswold Ram; bred by himself.

‡John Gillett, of Minster Lovell, near Witney, Oxon: for his 1 year and 3 months-old Cotswold Ram; bred by himself.

‡Thomas Porter, of Baunton, near Cirencester, Gloucester: for his 1 year and 4 months-old Cotswold Ram; bred by himself.

†Thomas Porter, of Baunton, near Cirencester: for his 2 years and 4 months-old Cotswold Ram; bred by himself.

†Edward Handy, of Sierford, near Cheltenham: for his 3 years and 3 months-old Cotswold Ram; bred by himself.

†Edward Handy, of Sierford, near Cheltenham: for his 3 years and 3 months-old Cotswold Ram; bred by himself.

‡Robert Garne, of Aldsworth, near Northleach: for his 2 years and 4 months-old Cotswold Ram; bred by the late William Garne, of Aldsworth.

‡Robert Garne, of Aldsworth, near Northleach: for his 3 years and 4 months-old Cotswold Ram; bred by the late William Garne, of Aldsworth.

‡William Smith, of Bibury, near Fairford, Gloucester: for his 3 years and 3 months-old Cotswold Ram; bred by himself.

†William Lane, of Broadfield Farm, near Northleach, Gloucestershire: for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

†T. Beale Browne, of Hampen, near Andoversford, Gloucester: for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

‡T. Beale Browne, of Hampen, near Andoversford, Gloucester: for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

‡William Lane, of Broadfield Farm, near Northleach, Gloucester: for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

‡John King Tombs, of Langford, near Lechlade: for his 1 year and 3 months-old Pen of five Shearling Cotswold Ewes; bred by himself.

†William Humfrey, of Oak Ash, Chaddleworth, near Wantage: for his 1 year and 4 months-old West Country Down Ram; bred by himself.

†Charles Howard, of Biddenham, near Bedford: for his 1 year and 4 months-old Oxfordshire Down Ram; bred by himself.

†John Bryan, of Southleigh, near Witney, Oxon: for his 1 year and 3 months-old Oxfordshire Down Ram; bred by himself.

†Joseph Druce, of Eynsham, near Oxford: for his 1 year and 4 months-old Oxfordshire Down Ram; bred by himself.

‡The Duke of Marlborough, of Blenheim, near Woodstock, Oxon: for his (about) 1 year and 4 months-old Oxfordshire Down Ram; bred by himself.

‡William Gillett, of Brize Norton, near Witney, Oxon: for his 1 year and 5 months-old Oxfordshire Down Ram; bred by himself.

‡Sampson Byrd, of The Leese Farm, near Stafford: for his 1 year and 3 months-old Shropshire Down Ram; bred by himself.

†THOMAS HORTON, of Harnage Grange, near Shrewsbury: for his 2 years and 3 months-old Shropshire Down Ram; bred by himself.

†JOHN BRYAN, of Southleigh, near Witney, Oxon: for his 5 years and 3 months-old Oxfordshire Down Ram; bred by himself.

†JOHN BRYAN, of Southleigh, near Witney, Oxon: for his 4 years and 3 months-old Oxfordshire Down Ram; bred by himself.

†JOHN BRYAN, of Southleigh, near Witney, Oxon: for his 2 years and 5 months-old Oxfordshire Down Ram; bred by himself.

†WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage, Berks: for his 2 years and 4 months-old West Country Down Ram; bred by himself.

HENRY L. GASKELL, of Kiddington Hall, near Woodstock, Oxon: for his 2 years and 3 months-old Oxfordshire Down Ram; bred by himself.

HENRY L. GASKELL, of Kiddington Hall, near Woodstock, Oxon: for his 2 years and 3 months-old Oxfordshire Down Ram; bred by himself.

MRS. BAKER, of Grendon, near Atherstone, Warwick: for her 3 years and 3 months-old Shropshire Ram; bred by herself.

JOHN H. BRADBURNE, of Pipe Place, near Lichfield, Staffordshire: for his 2 years and 3 months-old short-woolled Ram; bred by himself.

THOMAS HORTON, of Harnage Grange, near Shrewsbury: for his 2 years and 3 months-old Shropshire Down Ram; bred by himself.

JOHN COXON, of Freeford Farm, near Lichfield: for his 2 years and 3 months-old Shropshire Ram; bred by J. and E. Crane, of Sharwardine, Salop.

EDWARD HOLLAND, M.P., of Dumbleton Hall, near Evesham: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

EDWARD HOLLAND, M.P., of Dumbleton Hall, near Evesham: for his 3 years and 3 months-old Shropshire Ram; bred by himself.

STEPHEN KING, of Old Hayward Farm, near Hungerford, Berks: for his 2 years and 4 months-old West Country Down Ram; bred by himself.

WILLIAM ORME FOSTER, of Kinver Hill Farm, near Stourbridge: for his 3 years and 3 months-old Shropshire Ram; bred by himself.

WILLIAM ORME FOSTER, of Kinver Hill Farm, near Stourbridge: for his 3 years and 3 months-old Shropshire Ram; bred by himself.

JAMES MERSON, of Brinsworthy, near Northmolton, Devon: for his 3 years and 3 months-old Exmoor Ram; bred by himself.

JAMES MERSON, of Brinsworthy, near Northmolton, Devon: for his 4 years and 4 months-old Exmoor Ram; bred by himself.

JOHN MOORE, of Littlecott Farm, near Pewsey, Wilts: for his 2 years and 4 months-old Hampshire Down Ram; bred by T. Simpkins, of Abblington House, near Amesbury.

SAMUEL PERRY, of Shipley, near Claverley, Salop: for his 4 years and 3 months-old Shropshire Down Ram; bred by Alexander Farmer, of Shipley, near Claverley.

CHARLES STURGEON, of South Ockendon Hall, near Romford, Essex: for his 2 years and 4 to 5 months-old Merino Ram; bred by himself.

CHARLES STURGEON, of South Ockendon Hall, near Romford, Essex: for his 2 years and 4 to 5 months-old Merino Ram; bred by himself.

†WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage, Berks: for his 1 year and 4 months-old Pen of five Shearling West Country Down Ewes; bred by himself.

†THOMAS EDMOND MILLER, of Southfield Farm, Iffley, near Oxford: for his 1 year and 4 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by himself.

†JAMES and EDWARD CRANE, of Sharwardine, near Shrewsbury: for their 1 year and 3 months-old Pen of five Shearling Shropshire Ewes; bred by themselves.

†JOHN W. BROWN, of Uffcott, near Swindon, Wilts: for his 1 year and 6 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

†WILLIAM F. BENNETT, of Chilmark, near Salisbury: for his 1 year and 5 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

†JOHN MOORE, of Littlecott Farm, near Pewsey, Wilts: for his 1 year and 4 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

WILLIAM MOUNTAIN, of Beard Mill, Stanton Harcourt, near Witney, Oxon: for his 1 year and 4 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by himself.

WILLIAM HUMFREY, of Oak Ash, Chaddleworth, near Wantage, Berks: for his 1 year and 5 months-old Pen of five Shearling West Country Ewes; bred by himself.

GEORGE B. MORLAND, of Chilton Farm, near Harwell, Berks: for his 1 year and 4 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

HENRY L. GASKELL, of Kiddington Hall, near Woodstock, Oxon: for his 1 year and 3 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by himself.

GEORGE WALLIS, of Hinton Waldridge, near Faringdon, Berks: for his 1 year and 5 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by W. T. Wallis, of Shifford Lodge, near Bampton, Oxon.

WILLIAM BROWNE CANNING, of Chisledon, near Swindon, Wilts: for his 1 year and 4 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

MRS. BAKER, of Grendon, near Atherstone, Warwick: for her 1 year and 3 months-old Pen of five Shearling Shropshire Ewes; bred by herself.

HENRY MATTHEWS, of Montford, near Shrewsbury: for his 1 year and 3 months-old Pen of five Shearling Shropshire Ewes; bred by himself.

ROBERT COLES, of Middleton Farm, Norton Bavant, near Warminster, Wilts: for his 1 year and 4 months-old Pen of five Shearling Hampshire Down Ewes; bred by himself.

ROBERT COLES, of Middleton Farm, Norton Bavant, near Warminster, Wilts: for his 1 year and 4 months-old Pen of five Shearling Improved Hampshire Down Ewes; bred by himself.

JOSEPH DRUCE, of Eynsham, near Oxford: for his 1 year and 4 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by himself.

CHARLES HOWARD, of Biddenham, near Bedford: for his 1 year and 4 months-old Pen of five Shearling Oxfordshire Down Ewes; bred by himself.

STEPHEN KING, of Old Hayward Farm, near Hungerford, Berks: for his 1 year and 4 months-old Pen of five Shearling West Country Down Ewes; bred by himself.

THOMAS MANSELL, of Adcott Hall, near Shrewsbury: for his 1 year and 3 months-old Pen of five Shearling Shropshire Ewes; bred by himself.

WILLIAM ORME FOSTER, of Kinver Hill Farm, near Stourbridge, Worcester: for his 1 year and 3 months-old Pen of five Shearling Shropshire Ewes; bred by himself.

†JAMES and EDWARD CRANE, of Sharwardine, near Shrewsbury: for their 1 year and 3 months-old Shropshire Ram; bred by themselves.

†JOHN COXON, of Freeford Farm, near Lichfield, Staffordshire: for his 1 year and 3 months-old Shropshire Ram; bred by himself.

‡THOMAS MANSELL, of Adcott Hall, near Shrewsbury: for his 1 year and 3 months-old Shropshire Ram; bred by himself.

‡PRYCE WILLIAM BOWEN, of Sharwardine Castle, Salop: for his 1 year and 3 months-old Shropshire Ram; bred by himself.

†THOMAS HORLEY, JUN., of The Fosse, near Leamington, Warwick: for his 2 years and 4 months-old Shropshire Ram; bred by himself.

†J. COXON and C. W. THACKER, of Freeford Farm and Elford Park, near Lichfield, Staffordshire: for their 3 years and 3 months-old Shropshire Ram; bred by George Adney, of Harley, near Shrewsbury.

†THE EARL of DARTMOUTH, of Patshull, near Wolverhampton: for his 3 years and 2 months-old Shropshire Ram; bred by himself.

JOHN H. BRADBURN, of Pipe-place, near Lichfield, Staffordshire: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

THOMAS HORTON, of Harnage Grange, near Shrewsbury: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

THOMAS HORTON, of Harnage Grange, near Shrewsbury: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

EDWARD HOLLAND, M.P., of Dumbleton Hall, near Evesham, Gloucester: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

THE EARL OF DARTMOUTH, of Patshull, near Wolverhampton: for his 3 years and 3 months-old Shropshire Ram; bred by himself.

THE EARL OF DARTMOUTH, of Patshull, near Wolverhampton: for his 2 years and 3 months-old Shropshire Ram; bred by himself.

William Orme Foster, of Kinver Hill Farm, near Stourbridge: for his 2 years and 3 months-old Shropshire Ram; bred by himself.
William Orme Foster, of Kinver Hill Farm, near Stourbridge: for his 2 years and 3 months-old Shropshire Ram; bred by himself.
William Orme Foster, of Kinver Hill Farm, near Stourbridge: for his 3 years and 3 months-old Shropshire Ram; bred by himself.
William Orme Foster, of Kinver Hill Farm, near Stourbridge: for his 3 years and 3 months-old Shropshire Ram; bred by himself.
Thomas Horley, Jun., of The Fosse, near Leamington, Warwick: for his 2 years and 4 months-old Shropshire Ram; bred by himself.
Samuel C. Pilgrim, of The Manor Farm, Burbage, near Hinckley, Leicester: for his 2 years and 3 months-old Shropshire Ram; bred by himself.
Samuel C. Pilgrim, of The Manor Farm, Burbage, near Hinckley, Leicester: for his 2 years and 3 months-old Shropshire Ram; bred by himself.
The Earl of Aylesford, of Packington Hall, near Coventry: for his 2 years and 3 months-old Shropshire Ram; bred by himself.
†Thomas Horley, Jun., of The Fosse, near Leamington: for his 1 year and 4 months-old Pen of five Shropshire Theaves; bred by himself.
Henry Mathews, of Montford, near Shrewsbury: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.
The Earl of Dartmouth, of Patshull, near Wolverhampton: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.
George M'Kenzie Kettle, of Dallicott House, near Bridgenorth, Salop: for his 1 year and 4 months-old Pen of five Shropshire Theaves; bred by himself.
Thomas Docker, of Alton House, near Allesley, Warwick: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.
William Orme Foster, of Kinver Hill Farm, near Stourbridge, Worcester: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.
William Orme Foster, of Kinver Hill Farm, near Stourbridge, Worcester: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.
Thomas Horley, Jun., of The Fosse, near Leamington: for his 1 year and 4 months-old Pen of five Shropshire Theaves; bred by himself.
The Earl of Aylesford, of Packington Hall, near Coventry: for his 1 year and 3 months-old Pen of five Shropshire Theaves; bred by himself.

Pigs.

†Captain Curtis, of Pailton House, near Lutterworth, Leicester: for his 8 months-old Carhead Boar, of a large breed; bred by himself.
‖John Holdway, of Weston, near Bath: for his 6 months-old Essex Boar, of a small breed; bred by himself.
‖George Mangles, of Givendale, near Ripon: for his 2 years and 2 months-old Yorkshire and Cumberland Boar, of a small breed; bred by himself.
‖George Mangles, of Givendale, near Ripon: for his 2 years and 3 months-old Yorkshire and Cumberland Boar, of a small breed; bred by himself.
‖John Harrison, Jun., of Heaton Norris, near Stockport, Lancaster: for his 1 year and 5 months-old Boar, of a small breed; bred by G. Mason, of Warton Grange, Salop.
‖George M. Sexton, of Earl's Hall, Cockfield, near Sudbury, Suffolk: for his 1 year-old West Suffolk Improved Boar, of a small breed; bred by himself.
‖Robert H. Watson, of Bolton Park, near Wigton, Cumberland: for his 1 year and 11 months-old Boar, of a small breed; bred by Samuel Wiley, of Brandsby, near York.
‖Joseph Wilkinson, of Roundhay, near Leeds: for his 2 years-old Boar, of a small breed; bred by Lord Wenlock, of Escrick Park, near York.
‖Joseph Wilkinson, of Roundhay, near Leeds: for his 10 months-old Boar, of a small breed; bred by himself.
‖Thomas Pearson, of Moorville Terrace, Beeston Hill, near Leeds: for his 1 year and 10 months-old Boar, of a small breed; bred by himself.
‖Henry Mann, of The Asps, near Warwick: for his 8 months-old Boar, of a small breed; bred by himself.

‖Emile Pavy, à la Ferme de Girardet, Canton de Neuvy-roi, Indre-et-Loire, France: for his 20 months-old Middlesex Boar, of a small breed; bred by himself.

‖Samuel Druce, of Eynsham, near Oxford: for his 1 year-old improved Oxfordshire Boar, of a small breed; bred by Joseph Druce, of Eynsham.

‖George Horne, of The Brewery, Egham, near Staines, Middlesex: for his 6 months-old Boar, of a small breed; bred by himself.

‖The Earl of Radnor, of Coleshill House, near Highworth, Wilts: for his 2 years and 6 months-old Coleshill Boar, of a small breed; bred by himself.

‖The Rev. Frederick Thursby, of Abington Rectory, near Northampton: for his 1 year-old Cumberland Boar, of a small breed; bred by himself.

†John Harrison, Jun., of Heaton Norris, near Stockport: for his 2 years and 7 months-old Breeding-Sow, of a large breed; bred by Mr. James Clayton, of Poyton, near Stockport.

†John Spencer, of Villiers Hill, near Kenilworth, Warwick: for his 1 year-old Berkshire Breeding-Sow, of a large breed; bred by himself.

‖John Holdway, of Weston, near Bath: for his 7 months-old Suffolk Breeding-Sow, of a small breed; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick: for his 3 years-old Yorkshire Breeding-Sow, of a small breed; bred by the Hon. Colonel Pennant, of Penrhyn Castle, near Bangor.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick: for his 9 months-old Yorkshire Breeding-Sow, of a small breed; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick: for his 9 months-old Yorkshire Breeding-Sow, of a small breed; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick : for his 9 months-old Yorkshire Breeding-Sow, of a small breed ; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick ; for his 9 months-old Yorkshire Breeding-Sow, of a small breed ; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick: for his 9 months-old Yorkshire Breeding-Sow, of a small breed ; bred by himself.

‖Edward Umbers, of Wappenbury, near Leamington Spa, Warwick: for his 9 months-old Yorkshire Breeding-Sow, of a small breed; bred by himself.

‖William Hemming, of Coldicott, near Moreton-in-Marsh, Gloucester: for his 10 months-old Breeding-Sow, of a small breed; bred by himself.

‖Thomas Ivens, of Lutterworth, Leicester: for his 1 year and 10 months-old Breeding-Sow, of a small breed; bred by himself.

‖George Mangles, of Givendale, near Ripon: for his 1 year and 5 months-old Yorkshire and Cumberland Breeding-Sow, of a small breed; bred by himself.

‖George Mangles, of Givendale, near Ripon: for his 1 year and 7 months-old Yorkshire and Cumberland Breeding-Sow, of a small breed; bred by himself.

‖George Mangles, of Givendale, near Ripon: for his 2 years and 7 months-old Yorkshire and Cumberland Breeding-Sow, of a small breed; bred by himself.

‖George Mangles, of Givendale, near Ripon: for his 3 years and 3 months-old Yorkshire and Cumberland Breeding-Sow, of a small breed; bred by himself.

‖George Mangles, of Givendale, near Ripon: for his 4 years and 3 months-old Yorkshire and Cumberland Breeding-Sow, of a small breed; bred by himself.

‖John Harrison, Jun., of Heaton Norris, near Stockport: for his 2 years and 1 month-old Breeding-Sow, of a small breed; bred by himself.

‖George M. Sexton, of Earl's Hall, Cockfield, near Sudbury, Suffolk: for his 1 year and 3 months-old West Suffolk Improved Breeding-Sow, of a small breed; bred by himself.

‖George M. Sexton, of Earl's Hill, Cockfield, near Sudbury, Suffolk: for his 1 year-old West Suffolk Improved Breeding-Sow, of a small breed; bred by himself.

‖The Earl of Warwick, of Warwick Castle, Warwick: for his 11 months-old Breeding-Sow, of a small breed; bred by himself.

‖The Earl of Warwick, of Warwick Castle, Warwick; for his 2 years and 3 months-old Breeding-Sow, of a small breed; bred by himself from the stock of the late Earl of Warwick.

‖Robert H. Watson, of Bolton Park, near Wigton, Cumberland: for his 1 year-old Breeding-Sow, of a small breed; bred by himself.

||Joseph Wilkinson, of Roundhay, near Leeds: for his 1 year and 11 months-old Breeding-Sow; of a small breed; bred by himself.

||Joseph Wilkinson, of Roundhay, near Leeds: for his 1 year and 11 months-old Breeding-Sow, of a small breed; bred by himself.

||Joseph Hindson, of Barton House, Everton, near Liverpool: for his 1 year and 7 months-old Breeding-Sow, of a small breed; bred by himself.

||Joseph Hindson, of Barton House, Everton, near Liverpool: for his 2 years and 10 months-old Breeding-Sow, of a small breed; bred by himself.

||Richard Edward Ashton, of Limefield, near Bury, Lancaster: for his 1 year and 5 months-old Yorkshire Breeding-Sow, of a small breed; bred by John Harrison, jun., of Heaton Norris, near Stockport.

||Joseph Druce, of Eynsham, near Oxford: for his 1 year-old Improved Oxford Breeding-Sow, of a small breed; bred by himself.

||Thomas Crisp, of Butley Abbey, near Wickham Market, Suffolk; for his 1 year and 2 months-old Breeding Sow, of a small breed; bred by himself.

||Henry Mann, of the Asps, near Warwick: for his 8 months-old Breeding-Sow, of a small breed; bred by himself.

||Henry Mann, of the Asps, near Warwick: for his 2 years-old Breeding-Sow, of a small breed; bred by himself.

||Henry Mann, of the Asps, near Warwick: for his 8 months-old Breeding-Sow, of a small breed; bred by himself.

||Emile Pavy, à la ferme de Girardet, Canton de Neuvy-roi, Indre-et-Loire, France: for his 8 months-old Middlesex Breeding-Sow, of a small breed; bred by himself.

||George Horne, of The Brewery, Egham, near Staines, Middlesex: for his 6 months-old Breeding-Sow, of a small breed; bred by himself.

||George Horne, of The Brewery, Egham, near Staines, Middlesex: for his 3 years-old Improved Dorset Breeding-Sow, of a small breed; bred by John Coate, of Hammoon, near Blandford.

||George Horne, of The Brewery, Egham, near Staines, Middlesex: for his 3 years and 6 months-old Breeding-Sow, of a small breed; bred by Thomas Crisp, of Butley Abbey, Suffolk.

||Henry Edward Surtees, of Dane End, near Ware, Herts: for his 10 months-old Yorkshire Breeding-Sow, of a small breed; bred by himself.

||Benjamin Lambert, of The Grove, Brislington, near Bath: for his 7 months-old Essex Breeding-Sow, of a small breed; bred by himself.

||William Lort, of Great Heath, near Tenbury, Hereford: for his about 3 years-old Breeding-Sow, of a small breed; bred by himself.

||The Rev. Fred. Thursby, of Abington Rectory, near Northampton: for his 1 year-old Cumberland Breeding-Sow, of a small breed; bred by himself.

||The Rev. Fred. Thursby, of Abington Rectory, near Northampton: for his 3 years and 7 months-old Cumberland Breeding-Sow; bred by himself.

†William Hewer, of Sevenhampton, near Highworth, Wilts: for his 5 months-old Pen of three Berkshire Breeding-Sow-Pigs, of a large breed; bred by himself.

†Edward Bowly, of Siddington House, near Cirencester: for his 6 months-old Pen of three Improved Berkshire Breeding-Sow-Pigs, of a large breed; bred by himself.

‡William Hewer, of Sevenhampton, near Highworth, Wilts: for his 7 months-old Pen of three Berkshire Breeding-Sow-Pigs, of a large breed; bred by himself.

||Thomas Barber Wright, of the Quarry House, Great Barr, near Birmingham: for his 2 years and 10 months-old Berkshire Boar; bred by William Hewer, of Sevenhampton, near Highworth.

||John Hutt, of Water Eaton, near Oxford: for his 8 months-old Berkshire Boar, bred by himself.

||John Hutt, of Water Eaton, near Oxford: for his 8 months-old Berkshire Boar; bred by himself.

||William James Sadler, of Bentham Calcutt, near Cricklade, Wilts: for his 5 months-old Berkshire Boar; bred by himself.

||William James Sadler, of Bentham Calcutt, near Cricklade, Wilts: for his 6 months-old Berkshire Boar; bred by himself.

‖HASTINGS SANDERSON, of Gannaway Farm, near Warwick: for his 1 year and 11 months-old Berkshire Boar; bred by Joseph Smith, of Henley-in-Arden.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 1 year and 4 months-old Berkshire Boar; bred by William Hewer, of Sevenhampton.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 5 months-old Berkshire Boar; bred by himself.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 5 months-old Berkshire Boar; bred by himself.

‖WILLIAM HEWER, of Sevenhampton, near Highworth, Wilts: for his 5 months-old Berkshire Boar; bred by himself.

‖WILLIAM HEWER, of Sevenhampton, near Highworth, Wilts: for his 5 months-old Berkshire Boar; bred by himself.

‖W. B. SCOTT, of Queen's Hotel, Birmingham: for his 1 year-old Berkshire Boar; bred by G. Holyoake, of Wolverhampton.

‖JOHN HUTT, of Water Eaton, near Oxford: for his 2 years and 9 months-old Berkshire Sow; bred by himself.

‖WILLIAM JAMES SADLER, of Bentham Calcutt, near Cricklade, Wilts: for his 3 years and 2 months-old Berkshire Sow; bred by Thomas Plummer, of Lydiard, near Swindon.

‖JOSEPH SMITH, of Henley-in-Arden, Warwick: for his 6 years-old Berkshire Sow; bred by W. J. Sadler, of Bentham Calcutt, near Cricklade.

‖JOSEPH SMITH, of Henley-in-Arden, Warwick: for his 3 years and 5 months-old Berkshire Sow; bred by himself.

‖HASTINGS SANDERSON, of Gannaway Farm, near Warwick: for his 1 year-old Berkshire Sow; bred by himself.

‖HASTINGS SANDERSON, of Gannaway Farm, near Warwick: for his 1 year-old Berkshire Sow; bred by himself.

‖HASTINGS SANDERSON, of Gannaway Farm, near Warwick: for his 4 months-old Berkshire Sow; bred by himself.

‖HASTINGS SANDERSON, of Gannaway Farm, near Warwick: for his 4 months-old Berkshire Sow; bred by himself.

‖JOHN SPENCER, of Villiers Hill, near Kenilworth, Warwick: for his 1 year-old Berkshire Sow; bred by himself.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 1 year and 7 months-old Berkshire Sow; bred by W. J. Sadler, of Calcutt, near Cricklade.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 9 months-old Berkshire Sow; bred by himself.

‖HIS ROYAL HIGHNESS THE PRINCE CONSORT: for his 1 year and 1 month-old Berkshire Sow; bred by Thomas Pain, of Laverstock Hall, near Salisbury.

‖BENJAMIN SEDGLEY, of Heathcote, near Warwick: for his 2 years and 1 month-old Berkshire Sow; bred by himself.

‖EDWARD BOWLY, of Siddington House, near Cirencester, Gloucester: for his 2 years and 1 month-old Improved Berkshire Sow; bred by himself.

‖ROBERT OVERBURY, of Henley-in-Arden, Warwick: for his 3 years-old Berkshire Sow; bred by Mr. Taylor, of Wolverton, near Warwick.

‖THOMAS BARBER WRIGHT, of the Quarry House, Great Barr, near Birmingham: for his 4 months-old Pen of five Berkshire Breeding-Pigs; bred by himself.

‖WILLIAM JAMES SADLER, of Bentham Calcutt, near Cricklade, Wilts: for his 4 months-old Pen of five Berkshire Breeding-Pigs; bred by himself.

‖THE REV. HENRY G. BAILY, of Swindon, Wilts: for his 3 months-old Pen of five Berkshire Breeding-Pigs; bred by himself.

GEORGE MANGLES, of Givendale, near Ripon: for his 3 months-old Pen of five Yorkshire and Cumberland Breeding-Pigs, of a small breed; bred by himself.

GEORGE MANGLES, of Givendale, near Ripon: for his 4 months-old Pen of five Yorkshire and Cumberland Breeding-Pigs, of a small breed; bred by himself.

WILLIAM H. MAUND, of The Hill, Laverstock, near Salisbury: for his 15 weeks-old Pen of five Essex and Lord Portsmouth's breed Breeding-Pigs, of a small breed; bred by himself.

HENRY AMBLER, of Watkinson Hall Farm, near Halifax: for his 4 months-old Pen of five Yorkshire Breeding-Pigs, of a small breed; bred by himself.

Henry Ambler, of Watkinson Hall Farm, near Halifax: for his 4 months-old Pen of five Yorkshire Breeding-Pigs, of a small breed; bred by himself.

Henry Mann, of The Asps, near Warwick; for his 3 months-old Pen of five Breeding-Sow-Pigs, of a small breed; bred by himself.

John Palmer, of Thorlby, near Skipton: for his 4 months-old Pen of five Breeding-Pigs, of a small breed; bred by himself.

IMPLEMENTS.

John Fowler, Jun., of 28, Cornhill, London: the Prize of Fifty Sovereigns, for his 10-Horse Set of Steam-cultivating Apparatus; invented by himself, and manufactured by Clayton, Shuttleworth, and Co., of Lincoln, and R. Stephenson and Co., of Newcastle-on-Tyne: and his Balance Four-furrow Plough, fitted with Scarifier Irons; invented by himself, and manufactured by Ransomes and Sims, of Ipswich.

James and Frederick Howard, of Bedford: the Prize of Six Sovereigns, for their Two-wheeled Iron Plough (marked H H), adapted for General Purposes; invented, improved, and manufactured by themselves.

Richard Hornsby and Sons, of Spittlegate, Grantham: the Prize of Five Sovereigns, for their Iron Plough (marked H) adapted for General Purposes; invented, improved, and manufactured by themselves.

Ransomes and Sims, of Ipswich: the Prize of Four Sovereigns, for their Iron Plough (Y W B) adapted for General Purposes; invented, improved, and manufactured by themselves.

The Busby Agricultural Implement Company, of Newton-le-Willows, near Bedale, Yorkshire: the Prize of Two Sovereigns, for their Plough adapted for General Purposes; invented and improved by W. Busby, of Newton-le-Willows, and manufactured by the Exhibitors.

William Hensman and Son, of Linslade Works, near Leighton Buzzard, Bedfordshire: the Prize of One Sovereign, for their Iron Plough (marked N N) adapted for General Purposes; invented, improved, and manufactured by themselves.

Richard Hornsby and Sons, of Spittlegate, near Grantham: the Prize of Three Sovereigns, for their Iron Plough (marked H H H) adapted for Heavy Land; invented, improved, and manufactured by themselves.

James and Frederick Howard, of Bedford: the Prize of Two Sovereigns, for their Iron Plough (marked H H H) adapted for Heavy Land; invented and manufactured by themselves.

Ransomes and Sims, of Ipswich: the Prize of Two Sovereigns, for their Iron Plough (marked Y W C) adapted for Heavy Land; invented, improved, and manufactured by themselves.

William Ball, of Rothwell, Northamptonshire: the Prize of Thirty Shillings, for his Iron Plough adapted for Heavy Land; invented, improved, and manufactured by himself.

The Busby Agricultural Implement Company, of Newton-le-Willows, Bedale: the Prize of Thirty Shillings, for their Plough adapted for Heavy Land; invented by William Busby, of Newton-le-Willows, improved and manufactured by the Exhibitors.

Richard Hornsby and Sons, of Spittlegate, Grantham: the Prize of Four Sovereigns, for their Iron Plough (marked H) adapted for Light Land; invented, improved, and manufactured by themselves.

Ransomes and Sims, of Ipswich: the Prize of Three Sovereigns, for their Iron Plough (marked Y W A) adapted for Light Land; invented, improved, and manufactured by themselves.

JAMES and FREDERICK HOWARD, of Bedford: the Prize of TWO SOVEREIGNS, for their Iron Plough (marked H) adapted for Light Land; invented and manufactured by themselves.

WILLIAM HENSMAN and SON, of Linslade Works, near Leighton Buzzard: the Prize of ONE SOVEREIGN, for their Iron Plough (marked N) adapted for Light Land; invented, improved, and manufactured by themselves.

JOHN EDDY, of Kenford, near Exeter: the Prize of TWO SOVEREIGNS, for his Iron Turnwrest-Plough (marked K 6); invented, improved, and manufactured by himself.

JAMES and FREDERICK HOWARD, of Bedford: the Prize of FOUR SOVEREIGNS, for their Set of Jointed Harrows (marked No. 15) for Light Land; invented and manufactured by themselves.

JAMES and FREDERICK HOWARD, of Bedford: the Prize of THREE SOVEREIGNS, for their Set of Iron Harrows (marked No. 11) for Light Land; improved and manufactured by themselves.

EDWARD PAGE and Co., of Bedford: the Prize of TWO SOVEREIGNS, for their Set of Diagonal Iron Harrows (marked 1½) for Light Land; invented by S. L. Taylor, of Cotton End, and manufactured by the Exhibitors.

MESSRS. MAPPLEBECK and LOWE, of Birmingham: the Prize of TWO SOVEREIGNS, for their Chain Harrow; improved and manufactured by themselves.

JAMES and FREDERICK HOWARD, of Bedford: the Prize of FOUR SOVEREIGNS, for their Set of Iron Drag-Harrows (No. 17) for Heavy Land; improved and manufactured by themselves.

EDWARD PAGE and Co., of Bedford: the Prize of THREE SOVEREIGNS, for their Set of Diagonal Iron Harrows (No. 3) for Heavy Land; invented by S. L. Taylor, of Cotton End, and manufactured by themselves.

RANSOMES and SIMS, of Ipswich: the Prize of TWO SOVEREIGNS, for their Set of 4 East Anglian Harrows (No. 3) for Heavy Land; invented, improved, and manufactured by themselves.

EDWARD HAMMOND BENTALL, of Heybridge, Maldon: the Prize of FIVE SOVEREIGNS, for his Cultivator, Scarifier, and Subsoil Plough (marked L I B B) for Light Land; invented, improved, and manufactured by himself.

COLEMAN and SON, of Chelmsford: the Prize of THREE SOVEREIGNS, for their Five-Prong Cultivator, Grubber, or Scarifier (No. 5) for Light Land; invented by Richard Coleman, improved and manufactured by Exhibitors.

CHARLES CLAY, of Walton, near Wakefield: the Prize of TWO SOVEREIGNS, for his Cultivator and Twitchgrass Eradicator for Light Land; invented and manufactured by himself.

COLEMAN and SON, of Chelmsford: the Prize of FIVE SOVEREIGNS, for their Seven-Prong Cultivator, Grubber, or Scarifier for Heavy Land; invented by Richard Coleman, improved and manufactured by the Exhibitors.

EDWARD HAMMOND BENTALL, of Heybridge, Maldon: the Prize of THREE SOVEREIGNS, for his Cultivator, Scarifier, and Subsoil Plough for Heavy Land; invented, improved, and manufactured by himself.

RANSOMES and SIMS, of Ipswich: the Prize of TWO SOVEREIGNS, for their Wrought-Iron Scarifier (No. 7) for Heavy Land; improved and manufactured by themselves.

THE TRUSTEES of W. CROSSKILL, of Beverley: the Prize of FIVE SOVEREIGNS, for their Field-Roller; improved and manufactured by themselves.

HILL and SMITH, of Brierley Hill, Dudley: the Prize of THREE SOVEREIGNS, for their Wrought-Iron Universal Field-Roller; invented and manufactured by themselves.

HILL and SMITH, of Brierley Hill, Dudley: the Prize of TWO SOVEREIGNS, for their Wrought-Iron Light-Land Roller; invented and manufactured by themselves.

A. and E. CROSSKILL, of Beverley: the Prize of FIVE SOVEREIGNS, for their Clod-Crusher; improved and manufactured by themselves.

WILLIAM C. CAMBRIDGE, of Bristol: the Prize of THREE SOVEREIGNS, for his Double-action Press-Wheel Roller and Clod-Crusher; invented, improved, and manufactured by himself.

THE TRUSTEES of W. CROSSKILL, of Beverley: the Prize of TWO SOVEREIGNS, for their Clod-Crusher; invented and improved by W. Crosskill, and manufactured by themselves.

LOOMES and CO., of Whittlesea, Cambridgeshire: the Prize of TEN SOVEREIGNS (Local Prize), for their Three Sets of Draining-Pipes.

THOMAS SCRAGG, of Calveley, Tarporley: the Prize of THREE SOVEREIGNS, for his Single-action Drain-tile and Pipe-making Machine; invented, improved, and manufactured by himself.

JOHN WHITEHEAD, of Preston: the Prize of TWO SOVEREIGNS, for his Drain-Pipe and Tile Machine; invented, improved, and manufactured by himself.

A. and W. EDDINGTON, of Chelmsford: the Prize of FIFTEEN SOVEREIGNS, for their Draining Windlass; invented and manufactured by themselves: and a Draining Plough; invented by John Fowler, Jun., of London, and manufactured by Fowler and Fry, Bristol.

FRANCIS PARKES and CO., of Sutton Coldfield: the Prize of THREE SOVEREIGNS, for their Set of Warwickshire Draining Tools; improved and manufactured by themselves.

MAPPLEBECK and LOWE, of Birmingham: the Prize of TWO SOVEREIGNS, for a Set of Draining Tools; invented by Josiah Parkes, of London, and manufactured by W. A. Lyndon, of Birmingham.

JOHN WHITEHEAD, of Preston: the Prize of TEN SOVEREIGNS, for his Brick-making and Tile Machine; invented and manufactured by himself.

HUMPHREY CHAMBERLAIN, of Kempsey, Worcester: the Prize of FIVE SOVEREIGNS, for a Brick and Tile-making Machine; invented and manufactured by Messrs. Wright and Green, of Rugby.

WILLIAM TORR, of Aylesby Manor, Grimsby: the Prize of TEN SOVEREIGNS (Local Prize), for his Farm Gate; invented, improved, and manufactured by himself.

MEDALS.

WILLIAM SNOWDEN, of Longford, Gloucester: a SILVER MEDAL, for his Paring Plough; invented and improved by William Woofe, of Western Birt, Gloucester, and manufactured by the Exhibitors.

BURGESS and KEY, of 95, Newgate-Street, London: a SILVER MEDAL, for their Grass-Mowing Machine; invented by J. Allen, of New York, improved and manufactured by the Exhibitors.

SIDNEY FLAVEL and CO., of Leamington: a SILVER MEDAL, for their Kitchener; invented by Mr. Flavel, improved and manufactured by the Exhibitors.

THOMAS GIBBS and CO., of Half-Moon Street, Piccadilly: a SILVER MEDAL, for their collection of Agricultural Plants, Seeds, and Grain.

PETER LAWSON and SON, of Edinburgh, and 27, Great George Street, Westminster: a SILVER MEDAL, for their collection of Plants, Seeds, and Grain.

W. H. and GEORGE DAWES, of the Milton and Elsecar Iron Works, near Barnsley: a SILVER MEDAL, for their Atmospheric Hammer; invented by C. J. Carr, of Hoyland, Barnsley, and manufactured by the Exhibitors.

HUMPHREY CHAMBERLAIN, of Kempsey, Worcester: a SILVER MEDAL, for a Dry Clay Brick-making Machine: invented and manufactured by Messrs. Bradley and Craven, of Wakefield.

HUMPHREY CHAMBERLAIN, of Kempsey, Worcester: a SILVER MEDAL, for a Brick-making Machine; invented and manufactured by Messrs. Bradley and Craven, of Wakefield.

EMILE PAVY, à la Ferme de Girardet, près Canton de Neury-roi, Indre-et-Loire, France: a SILVER MEDAL, for a Granary; invented and improved by himself, manufactured by Renaud and Lotey, of Nantes, France.

Commendations.

The mark * signifies "HIGHLY COMMENDED;" and the mark † "COMMENDED."

*JOHN FOWLER, JUN., of 28, Cornhill, London: for his Set of Steam-Cultivating Apparatus; invented by himself, manufactured by Clayton, Shuttleworth, and Co., of Lincoln, and R. Stephenson and Co., of Newcastle-on-Tyne: and his Balance Three-Furrow Plough; invented by himself and manufactured by Ransome and Sims, of Ipswich.

*WILLIAM BALL, of Rothwell, Northamptonshire: for his Plough for General Purposes, No. 8; invented, improved, and manufactured by himself.

*THE BUSBY AGRICULTURAL IMPLEMENT COMPANY, of Newton-le-Willows, Bedale: for their Light-Land Plough; invented and improved by W. Busby, manufactured by the Exhibitors.

*WILLIAM BALL, of Rothwell: for his Light-Land Plough (marked B C 9 Patent); invented, improved, and manufactured by himself.

*EDWARD PAGE and Co., of Bedford: for their Light-Land Plough "Eclipse;" invented and manufactured by themselves.

*RANSOMES and SIMS, of Ipswich: for their Turnwrest Plough; invented by Henry Locock, improved and manufactured by the Exhibitors.

*EDWARD HAMMOND BENTALL, of Heybridge, Maldon: for his Set of 4-Beamed Heavy-Land Harrows (No. 413); invented, improved, and manufactured by himself.

*RANSOMES and SIMS, of Ipswich: for their Set of Four East Anglian Seed-Harrows for Light Land; invented, improved, and manufactured by themselves.

*JOHN CARTWRIGHT, of Shrewsbury: for his Double-action Combined Clod-crusher and Press-wheel Roller; invented, improved, and manufactured by himself.

*HOLMES and SONS, of Prospect-place, Norwich: for their Roller for Light Land; invented, improved, and manufactured by themselves.

*JOHN CARTWRIGHT, of Shrewsbury: for his Medium Self-relieving Chain-harrow: invented, improved, and manufactured by himself.

*HOLMES and SONS, of Norwich: for their Portable Saw-Bench; invented, improved, and manufactured by themselves.

*HENRY BRIDGES, of 406, Oxford-street, London; for his large variety of Butter-Prints; invented and manufactured by himself.

†JAMES and FREDERICK HOWARD, of Bedford, and WILLIAM SMITH, of Woolston: for their Set of Patent Apparatus for Cultivating Land by Steam Power; invented by William Smith, of Woolston, and manufactured by J. and F. Howard, of Bedford, and their Patent Self-propelling Portable Steam-Engine; invented and manufactured by Clayton and Shuttleworth, of Lincoln.

†W. Goulding and Co., of Leicester: for their Iron Plough (marked R A B) for Light Land; invented and manufactured by themselves.

†James Comins, of Southmolton: for his Set of Improved Harrows for Light Land; invented, improved, and manufactured by himself.

†Page and Co., of Bedford: for their Pair of Drag-Harrows (No. 5) for Heavy Land; manufactured by themselves.

†Hugh Carson, of Warminster: for his Seven-share Cultivator or Scarifier for Light Land: invented, improved, and manufactured by himself.

†James Woods and Son, of Stowmarket: for their Wrought-Iron Barley-Roller; improved and manufactured by themselves.

†Coleman and Son, of Chelmsford: for their Clod-crusher: invented by Richard Coleman, and manufactured by the Exhibitors.

†William C. Cambridge, of Bristol: for his Jointed Self-expanding Chain-Harrow: invented, improved, and manufactured by himself.

†Thomas Scragg, of Calveley, Tarporley: for his Three Sets of Draining Pipes; manufactured by himself.

†John Robinson, of Nuneaton: for his Three Sets of Draining Pipes: manufactured by himself.

†John Whitehead, of Preston: for his Brick-Pressing Machine; invented, improved, and manufactured by himself.

†Benjamin Fowler, of Whitefriars-street, London: for his Pump with Foot-piece Valve: invented, improved, and manufactured by B. Fowler and Co.

†Burgess and Key, of 95, Newgate-street, London: for their Horse-hoe with Revolving-brushes for destroying Insects: invented by W. A. Munn, Esq., of Throwley House, Feversham, and manufactured by the Exhibitors.

†Robert Maynard, of Whittlesford, Cambridge: for his Dibbling-machine; invented by C. Clarke, of Newmarket, and Robert Maynard, and manufactured by the Exhibitor.

†A. and E. Crosskill, of Beverley: for their Iron Cart for Liquid Manure or Water; invented by W. Crosskill, improved and manufactured by the Exhibitors.

†S. and E. Ransome and Co., of 31, Essex-street, London: for their Argand Fire-bars; invented and manufactured by Martin and Co., of London.

†Perry and Son, of Highfields Works, near Bilston: for their exhibition of Iron Gates, Fences, Trays, and other articles.

†The Trustees of W. Croskill, of Beverley: for their large show of Carts, Carriages, and Wheels.

†Benjamin Heel, of Warwick: for his Cooperage.

†Peyton and Clark, of Birmingham: for their large assortment of Tools.

†The St. Pancras Iron-Works Company, Old St. Pancras-road, London: for their Stable Fittings and General Collection.

†Barrett, Exall, and Andrews, of Reading: for their Show of Machinery.

†William Roberts, of Northampton: for his Collection of Ornamental Chairs and other useful articles.

†Thomas Johnson and Son, of Leicester: for their Collection of Garden-seats, Ornamental Vases, &c.

†James Woods and Son, of Stowmarket: for a Cabinet Mangle: invented by John Halls, of Bildestone, improved and manufactured by the Exhibitors.

†Warner and Sons, of 8, Crescent, Jewin-street, London: for their Collection of Hydraulic Machinery.

†Priest and Woolnough, of Kingston-on-Thames: for their Turnip-duster and Fly-destroyer; invented by J. J. Rowley, of Rowthorne, improved and manufactured by the Exhibitors.

†Mapplebeck and Lowe, of Birmingham: for a large Collection of Useful Articles.

†Hill and Smith, of Brierley Hill, Dudley: for their extensive Collection, particularly of Gates and Fences.

†Francis Morton, of James-street, Liverpool: for his Wire-straining Pillar and Fencing; invented, improved, and manufactured by himself.

CHEESE.

JOHN M. BAKER, of Dordon Hall, Atherstone: the Champion Prize of THIRTY SOVEREIGNS, for his Four Cheeses, weighing not less than 35 lbs. each; made in 1858.

JOHN A. BEALE, of Brockhurst, Lutterworth: the Prize of TWENTY SOVEREIGNS, for his Four Coloured Cheeses, weighing not less than 35 lbs. each; made in 1858.

THOMAS HADDON, of Hampton Lucy, Warwick: the Prize of TWENTY SOVEREIGNS, for his Four Uncoloured Cheeses, weighing not less than 35 lbs. each; made in 1858.

GEORGE THOMAS SPOKES, of Little Lawford, Rugby: the Prize of FIFTEEN SOVEREIGNS, for his Four Coloured Cheeses, weighing not less than 25 lbs. each, and under 35 lbs.; made in 1858.

THOMAS SATCHWELL, of Hernfield House, Knowle, Warwick: the Prize of TEN SOVEREIGNS, for his Four Coloured Cheeses, weighing not less than 25 lbs. each, and under 35 lbs.; made in 1858.

WOOL.

GEORGE READING, of Priors Hardwick, Stockton, near Rugby: the Prize of TEN SOVEREIGNS, for his Six Fleeces of Leicester Teg Wool, shorn from yearling sheep.

THE DUKE OF RICHMOND, Goodwood, Chichester: the Prize of TEN SOVEREIGNS, for his Six Fleeces of Southdown Teg Wool, shorn from sheep 1 year and 4 months old.

SAMUEL PRATT, of Bubbenhall, near Kenilworth: the Prize of TEN SOVEREIGNS, for his Six Fleeces of Gloucester Teg Wool, shorn from sheep about 15 months old.

THOMAS HORTON, of Harnage Grange, Shrewsbury: the Prize of TEN SOVEREIGNS, for his Six Fleeces of Shropshire Teg Wool, shorn from sheep about 13½ months old.

COMMENDED.

WILLIAM HURLSTON, of Heathcote, Wasperton, Warwick: for his Six Fleeces of Leicester Teg Wool, shorn from sheep 13 months old.

JOHN SPENCER, of Villiers Hill, Kenilworth: for his Six Fleeces of Leicester Teg Wool, shorn from sheep 16 months old.

Essays and Reports.—PRIZES FOR 1860.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. AGRICULTURE OF BERKSHIRE.

FIFTY SOVEREIGNS will be given for the best Report on the Agriculture of Berkshire.

The principal geological and physical features of the county should be described; the nature of the Soil and character of the Farming in its different districts or natural divisions; its Live Stock; Implements; striking changes of Farm Management since the date of Report to the Board of Agriculture; Improvements recently introduced or still required; remarkable or characteristic Farms.

II. APPLICATION OF MANURE.

TWENTY SOVEREIGNS will be given for an approved Essay on the best period of the Rotation and the best time of year for applying the Manure of the Farm.

III. INFLUENCE OF PRICES ON FARM MANAGEMENT.

TEN SOVEREIGNS will be given for the best Essay on the alterations rendered advisable in the Management of Land of different qualities, by low prices of Grain and high prices of Meat.

Competitors will be expected to point out the best mode of maintaining the aggregate farm returns, by making increased receipts from live stock compensate for a fall in the value of grain.

IV. LATE IMPROVEMENTS IN DAIRY PRACTICE.

TEN SOVEREIGNS will be given for the best Essay on recent improvements in Dairy Practice.

A detailed account should be given of any improvements in the management or machinery employed in the manufacture of Cheese or Butter which have been recently adopted, and which have been found to increase the quantity or improve the quality of the produce.

V. THE PROPER OFFICE OF STRAW ON A FARM.

TEN SOVEREIGNS will be given for the best Essay on the proper office of Straw on the Farm.

The Essay must be based upon the teachings of both Practice and Science, in order that a proper value may be assigned to the nutritive qualities of Straw as cattle food, and to its fertilizing properties when used simply as manure. The extent to which it should be used as fodder and litter respectively, and the most approved and economical methods of employing it for either purpose, should be discussed.

VI. FARM CAPITAL.

TEN SOVEREIGNS will be given for the best Essay on the Amount of Capital required for the profitable occupation of a Farm.

The great differences existing between different farms as to soil, climate, style of agriculture, proportion of grass-land, &c., should be taken into account. The proper distribution of capital should be specified under general heads, as well as the total amount required.

VII. SEED-BED FOR AGRICULTURAL CROPS.

TEN SOVEREIGNS will be given for the best Essay on the conditions of Seed-bed best suited to the various agricultural crops.

The writer should first point out, in the case of all ordinary farm crops, the conditions of seed-bed most conducive to healthy vegetation, with reference to firmness, fineness of texture, and moisture, on soils of different quality, and then describe the agricultural operations best calculated to attain the desired result. The quantity of seed per acre; its mode of deposit; depth of covering; subsequent rolling, harrowing, &c., should be considered.

VIII. ADULTERATION OF SEEDS.

TEN SOVEREIGNS will be given for the best Essay on the Adulteration of Agricultural Seeds.

Reliable data should be furnished, founded upon a sufficiently extended experience and observation of ordinary market samples, showing the proportion often met with of seeds that have lost their vegetative power, or of the seeds of weeds. The writer should also point out the readiest mode of detecting adulteration.

IX. ANY OTHER AGRICULTURAL SUBJECT.

TEN SOVEREIGNS will be given for the best Essay on any other agricultural subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1860. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.*

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Members' Privileges of Chemical Analysis.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for Members of the Society; who (to avoid all unnecessary correspondence) are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.—An opinion of the genuineness of Peruvian guano, bone-dust, or oil-cake (each sample)	5s.
„ 2.—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia	10s.
„ 3.—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda	10s.
„ 4.—An analysis of superphosphate of lime for soluble phosphates only	10s.
„ 5.—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia ..	£1.
„ 6.—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure	£1.
„ 7.—Limestone:—the proportion of lime, 7*s.* 6*d.*; the proportion of magnesia, 10*s.*; the proportion of lime and magnesia	15s.
„ 8.—Limestone or marls, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay ..	£1.
„ 9.—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1.
„ 10.—Complete analysis of a soil	£3.
„ 11.—An analysis of oil-cake, or other substance used for feeding purposes; showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate	£1.
„ 12.—Analyses of any vegetable product	£1.
„ 13.—Analyses of animal products, refuse substances used for manure, &c.	from 10s. to 30s.
„ 14.—Determination of the "hardness" of a sample of water before and after boiling	10s.
„ 15.—Analysis of water of land drainage, and of water used for irrigation	£2.
„ 16.—Determination of nitric acid in a sample of water	£1.

N.B.—*The above Scale of Charges is not applicable to Analyses made for Persons commercially engaged in the Manufacture of any Substance for Sale.*

The Address of Professor Voelcker, the Consulting Chemist of the Society, is Cirencester, Gloucestershire, to which he requests that all letters and parcels (postage and carriage paid) should be directed: for the convenience, however, or persons residing in London, parcels sent to the Society's Office, No. 12, Hanover Square, will be forwarded to Cirencester once or twice a week.

Members' Veterinary Privileges.

I.—Veterinary Inspection.

No. 1. Any member of the Society who may desire a competent professional opinion and special advice in cases of extensive or destructive disease among his stock, and will address a letter to the Secretary, will, by return of post, receive a printed list of queries, to be filled up and returned to him immediately. On the receipt of such returned list, the Secretary will convene the Veterinary Committee forthwith (any two Members of which, with the assistance of the Secretary, will be competent to act); and such Committee will decide on the necessity of despatching Professor Simonds, the Society's Veterinary Inspector, to the spot where disease is said to prevail.

No. 2. The remuneration of such Inspector will be 2*l.* 2*s.* each day as a professional fee, and 1*l.* 1*s.* each day on account of personal expenses; and he will also be allowed to charge the cost of travelling to and from the localities where his services may have been thus required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant for professional aid. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them under peculiar circumstances by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, shall report to the Committee, in writing, the results of his observations and proceedings, which report will be laid before the Council.

No. 4. Should contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

II.—Investigations, Lectures, and Reports.

No. 1. All Members of the Society have the privilege of sending cattle, sheep, and pigs to the Royal Veterinary College, on the same terms as if they were Members of the College.

No. 2. The College have undertaken to investigate such particular classes of disease, or special subjects connected with the application of the Veterinary art to cattle, sheep, and pigs, as may from time to time be directed by the Council.

No. 3. In addition to the increased number of lectures now given by Professor Simonds, the Lecturer on Cattle Pathology, to the Pupils in the Royal Veterinary College, he will also deliver such lectures before the Members of the Society, at their house in Hanover Square, or at its Annual Meetings in the country, as the Council may decide.

No. 4. The Royal Veterinary College will from time to time furnish to the Council of the Society a detailed Report of the cases of cattle, sheep, and pigs treated in the College.

Royal Agricultural Society of England.

1859—1860.

President.

LORD WALSINGHAM.

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Publisher—JOHN MURRAY, 50, Albemarle Street, W.
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MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the new postal district designated by the letter W, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, May 22, 1860, at Twelve o'clock.

COUNTRY MEETING at Canterbury, in the week commencing July 9th, 1860.

GENERAL MEETING in London, in December, 1860.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Easter, Passion, and Whitsun weeks, when those weeks do not include the first Wednesday of the month; from the first Wednesday in August to the first Wednesday in November; and from the first Wednesday in December to the first Wednesday in February.

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(A statement of these privileges will be found in the present Appendix, p. lix.)

CHEMICAL ANALYSIS.—The privileges of Chemical Analysis enjoyed by Members of the Society will be found stated in the Appendix of the present volume, p. lviii.

LOCAL CHEQUES.—Members are particularly requested not to forward Country Cheques for payment in London; but London Cheques, or Post-office Orders (payable to H. HALL DARE), in lieu of them. All Cheques are required to bear upon them a penny draft or receipt stamp, which must be cancelled in each case by the initials of the drawer. They may also conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4	ounces	(or quarter of a pound)	1 penny.
,, ,, ,,	8	,,	(or half a pound)	2 pence.
,, ,, ,,	16	,,	(or one pound)	4 ,,
,, ,, ,,	24	,,	(or one pound and a half)	6 ,,
,, ,, ,,	32	,,	(or two pounds)	8 ,,

[And so on in the proportion of 8 ounces for each additional 2*d.*]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, of Chemical and Veterinary Privileges, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Friday, December 9, 1859.

REPORT OF THE COUNCIL.

The Society consists at the present time of—

79 Life Governors,
128 Annual Governors,
933 Life Members,
4082 Annual Members, and
18 Honorary Members,

making a total of 5240 Members, or an increase of 79 names since the last half-yearly Meeting.

The funded property of the Society amounts to 10,000*l.* stock, standing in the names of the Trustees in the New Three per Cents.

The Council regret to have to report the unfortunate circumstance that has taken place, and which led, first to the suspension, and subsequently to the dismissal, of the late Mr. James Hudson from the office of Secretary to the Society.

In the month of May last it came to the knowledge of the Finance Committee that certain moneys received by the Secretary on account of the Salisbury, Chester, and Warwick country meetings had not been paid by him to the Society's bankers.

They therefore immediately employed a professional accountant to investigate the accounts; and the result was reported to a Special Council, called by the President for the purpose, on the 27th of May.

The Council, having taken the matter into consideration, determind to suspend Mr. Hudson from the office of Secretary, and appointed a Special Committee, who were charged with fully investigating the exact state of the Secretary's accounts.

From the report of this Committee it appeared that the accountant had discovered an amount due from Mr. Hudson, consisting chiefly of payments received by him from exhibitors of implements for shedding, for entrance fees on live stock and implements, fines, and small amounts, making a total of 1933*l.* 8*s.* 3*d.* The different moneys forming this amount had not been entered in his cash-book, or accounted for to the Finance Committee as received, and had not been paid in to the bankers according to the bye-laws.

The Council therefore dismissed Mr. Hudson from the office of Secretary, and withheld the payment of the salary due to him amounting to 161*l.* 19*s.* 9*d.*

Whilst legal advice was being taken as to the course which should be pursued in this very difficult matter, the death of Mr. Hudson occurred.

It appeared that, a short time before his decease, Mr. Hudson executed a deed of assignment, making over the whole of his effects for the benefit of his creditors; and, under legal advice, the Council determined to come in as creditors under the deed in question, and authorized the Honorary Acting Secretary to sign it on behalf of the Society for the balance due, viz. 1771*l.* 8*s.* 6*d.*

At present it is impossible to ascertain definitely what dividend will be realized; but it is hoped that this large amount will be considerably reduced by it.

The total loss which the Society may have to sustain will be further lessened by the business of the Society having been carried on without a paid Secretary for the last seven months.

The Finance Commitee who were acting at the time when Mr. Hudson's deficiency was discovered having tendered their resignation, in order that the future course of the Council might

be left perfectly free, the Council have appointed a fresh Finance Committee, who will be charged with such reorganization of the accounts as may be deemed necessary.

The Council, however, have much pleasure in being able to report that, notwithstanding the funds having sustained a diminution by the large amount due from the late Secretary, not only have they found it unnecessary to touch the funded capital of the Society, but that its financial position is unusually satisfactory, the balance at the bankers' on the 7th inst. being 1711*l*., whilst the claims on the Society consist only of the ordinary current expenses.

After the suspension of Mr. Hudson, and again after his dismissal, and at the request of the Council, Mr. Brandreth Gibbs consented to undertake the office of Honorary Acting Secretary *pro tem.*, for which valuable assistance the Council desire to offer to him their most grateful acknowledgments.

The Council have come to the resolution of requiring the new Secretary to the Society to find approved security to the amount of 1000*l.*; they further require that he shall pay all amounts received by him on account of the Society in to the bankers forthwith; and they have laid down rules which, they trust, will render impossible a recurrence of any irregularity in the Society's business.

The Council have now elected Mr. Henry Hall Dare as Secretary, at a salary of 400*l.* per annum, with residence, fire, and lighting; and they have every reason to hope, from the testimonials they have received, that he will discharge the duties of the office to the satisfaction of the Council and the Members at large.

It has also been determined to appoint a professional accountant, constantly to examine the Society accounts, and report any irregularity to the Finance Committee, and also to suggest any improvements which may from time to time appear to be needed in the system of keeping the books.

The Council have determined to appoint a literary and scientific

Editor of the Society's Journal, at a salary of 500*l.* per annum; his duties to be performed under the general superintendence of the Journal Committee, and his whole time to be at the disposal of the Society.

The Council have recorded their high appreciation of the valuable services rendered by Mr. H. S. Thompson, M.P., and the other members of the Journal Committee, in conducting the Journal up to the present time.

The Warwick meeting was in every way eminently successful, and the number of visitors who thronged the show-yard gave evident proof that the interest taken in the Society's country meetings remains unabated, whilst the entries of live stock and implements were unusually large; indeed, the enormous display of the latter appears a satisfactory indication that the present quadrennial classification of implements for trial and prizes in no way interfered with the variety and general excellence of the exhibition as a whole.

The Mayor and Corporation, aided by a local committee acting under their authority, rendered every assistance in carrying out all the arrangements that were necessary to be made in the locality. The competition for the local prizes for cattle, horses, sheep, pigs, cheese, wool, and farm-gates tended considerably to increase the interest of the meeting.

The Council have also to acknowledge the courtesy of the County Magistrates, in giving the use of the Judges' lodgings for the accommodation of the Stewards of the Society during the period they were at Warwick.

The arrangements that were decided on for the supply of refreshments in the show-yard were a great improvement on former years.

The Council have fixed that the Canterbury Meeting shall take place in the week commencing Monday the 9th July next.

The Council have determined on the following arrangements for the Meeting:—

That the Live Stock shall all be in the yard the afternoon of

Saturday the 7th of July, which will allow of their recovering from the fatigue of the journey to the Show previous to the Judges commencing their inspection on the Monday morning following. That the exhibition shall close on the Thursday evening, thus enabling exhibitors' servants and animals to return home without breaking into another week.

It has been determined to add to the Prize List a Class for Heifer Calves in the Shorthorn, Hereford, and Devon divisions; also to form separate divisions for the Shropshire breed of Sheep, and the Kentish or Romney Marsh breed of Sheep; and to classify Pigs as follows, viz.: Large breed of any colour; Small white; Small black; and pigs not eligible for the preceding classes.

The Schedule of Prizes for Implements and Machinery for 1860, according to the quadrennial system which came into operation last year, will contain Classes for Thrashing Machines, Chaff-cutters, Mills, Crushers, Oilcake Breakers, Bone Mills, Turnip-cutters, &c.; and to these the Council have added additional Classes for the application of Steam-power to the Cultivation of the Soil, for Hand Tools used in Hop Grounds and Land Tillage, and for Field-gates.

The Local Committee at Canterbury having expressed their wish to offer certain Local Prizes, the Council have determined to accept those for Hops and Wool, to be competed for under such conditions as the Council may determine.

The Schedule of prizes offered for essays and reports, to be sent to the Secretary by the 1st March next, will be found on page liv.

A reprint has been made of Dr. Lang's Prize Essay on the Potato. This can now be purchased at a reduced rate.

The Society have from time to time been favoured, by order of the Secretary of State for Foreign Affairs, with copies of despatches received by Her Majesty's Government relative to guano and mineral deposits. Extracts from these communica-

tions have appeared in the published reports of the Council Meetings before which they were laid.

The Council have the satisfaction of recording their belief that the Society is steadily progressing, and that, by adopting such improvements in its proceedings as experience may from time to time show to be necessary, it will continue to maintain its important position in promoting the advancement of scientific and practical agriculture.

By order of the Council,

B. T. Brandreth Gibbs, Hon. Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-Yearly Account, extending from the 1st of January to the 30th of June, 1859.

Receipts.

	£.	s.	d.
Balance in the hands of the Bankers, Dec. 31, 1858	649	11	6
Petty Cash Balance in the hands of the Secretary, Dec. 31, 1858	33	15	5
Dividends on Stock	146	17	6
Governors' Annual Subscriptions	385	0	0
Members' Life-Compositions	233	0	0
Members' Annual Subscriptions	1790	2	0
Journal Receipts	193	7	2
Country-Meeting Receipts:—			
Warwick	2144	6	9
	£5576	0	4

Payments.

	£.	s.	d.
Permanent Charges	171	17	6
Taxes and Rates	9	5	6
Establishment	493	5	10
Postage and Carriage	18	10	7
Advertisements	5	7	3
Journal Payments	996	8	10
Veterinary Grant	100	0	0
Chemical Grant	350	0	0
Country Meeting Payments:—			
Chester	235	18	11
Warwick	1074	0	8
Subscription (paid in error by Bankers) returned	14	5	0
Sundry items of Petty Cash	3	5	2
Petty Cash in hands of the late Secretary not accounted for	49	8	5
Balance in the hands of the Bankers, June 30, 1859	2047	18	7
Petty-Cash Balance in hand, June 30, 1859	6	8	1
	£5576	0	4

(Signed) THOMAS RAYMOND BARKER, *Chairman*,
C. B. CHALLONER,
HENRY WILSON,
} *Finance Committee.*

Examined, audited, and found correct, this 2nd day of December, 1859.

(Signed) WILLIAM ASTBURY,
JOSEPH DRUCE,
} *Auditors on the part of the Society.*

COUNTRY MEETING

RECEIPTS

	£.	s.	d.
Subscription from Chester	1800	0	0
Interest on Exchequer Bonds	31	6	3
Admissions to Show Yard	6187	5	5
Sale of Catalogues	522	13	2
Sale of Dinner Tickets	170	8	0
Sale of Council Badges	5	5	6
Sale of Wheat, Barley, Oats, Straw, &c.	280	11	0

	£	s.	d.
Non-Members' Fees for Entry of Implements	33	15	0
Implement Exhibitors' Payment for Shedding	705	15	0
Fees for Entry of Live Stock	506	17	6
Fees for Entry of Cheese and Butter	48	0	0
Fines for Non-Exhibition of Live Stock	9	5	0
Extra Lines in Implement Catalogues	10	15	0
	£1314	7	6

deficit on the Chester account from the late Secretary.

£8997 9 4

NOTE.—The Local Prizes:—viz., £910 for Stock, £365 for Cheese, and £15 for Butter (total £1290)—are not
hands of the

ACCOUNT.—CHESTER, 1858.

EXPENDITURE.

	£.	s.	d.
Contract for Show and Trial Yard Works	2245	16	7
Extra Works in Show Yard	562	2	2
Hire of Entrance Turnstiles	84	0	0
Hire of Hurdles	141	13	4
Hire of Poultry Pens	20	17	6
Shafting for Machinery in Motion	10	0	0
Hire of Steam Engines	20	0	0
Judges of Implements	229	0	0
„ Live Stock and Poultry	256	0	0
„ Cheese and Butter	48	0	0
Consulting Engineer and Assistants	212	7	11
Veterinary Inspector and Assistants	26	0	0
Lodgings for Stewards, Judges, &c.	170	0	0
Refreshments for Stewards, Judges, &c.	83	8	6
Yardmen, Watchmen, and Cheesemen	147	5	6
Catalogue Sellers	18	18	0
Money Takers	40	19	0
Index Clerk, Money Changer, Door-keeper, &c.	35	9	0
Foremen and Sub-foremen of various Departments	56	10	0
Director's Clerks and Assistants	72	0	11
Extra Clerk at Society's Office	18	10	0
Bankers' Clerks	16	16	0
Clerk and Porter at Grand Stand	5	5	0
Wheat	503	14	10
Barley	110	0	0
Oats and Beans	37	8	0
Hay and Straw	89	12	10
Vetches	143	17	10½
Mangold Wurzel	19	17	6
Oil Cake	3	17	0
Milk and Cream	8	8	0
Coals	9	15	3
Baskets, Rakes, Sacks, and Sundry Tools	27	6	10
Twine	3	10	0
Hire of Land	18	0	0
Horse Labour	3	0	0
Surveying Crops	5	10	6
Hire of Farm Horses	99	0	0
Metropolitan Police	121	9	6
Hire of Horse for Police	2	16	0
Stationery and Postage Stamps for Director	24	3	10
Music Hall Fittings and Rent	75	0	0
Dinner Contract	200	0	0
Dinner Tickets, Circulars, Bill of Fare, Toast Lists, &c.	4	10	0
Miscellaneous Printing for Show Yard	2	1	6
Prize Sheets	34	16	0
Certificates	33	3	0
Railway Papers	18	15	6
Programmes	6	15	0
Labels, Admission Orders, Tickets, Circulars, &c.	116	16	0
Implement Catalogues	320	4	3
Live-Stock Catalogues	123	3	6
Lithographed Plan of Show Yard for Catalogues	22	19	0
Implement and Cheese Award-Sheets	13	10	6
Live-Stock Award-Sheets	85	10	0
Posters	33	9	0
Packing-cases for Catalogues	13	7	6
Badges for Members of Council, Stewards, Judges, &c.	9	0	3
Advertisements	102	17	0
Small Bills and Petty Payments at Chester	22	14	6
Postage and Carriage	18	5	4
Implement Prizes Awarded and Paid	767	0	0
Live-Stock and Poultry Prizes Awarded and Paid	1359	0	0
Medals	30	11	6
Official Staff—Board, Lodging, and Travelling Expenses	25	17	10
Sundry Petty Cash Payments	1	6	8
	£9193	1	2½

included in the above Account, as they were paid by the Chester Local Committee, and did not pass through the Society's Bankers.

(Signed) THOS. RAYMOND BARKER, *Chairman.*
C. B. CHALLONER.
SAMUEL JONAS.
HENRY WILSON.

COUNTRY MEETING

RECEIPTS.				£.	s.	d.
Subscription from Warwick				1500	0	0
Admissions to Show-Yard				5461	4	11
Sale of Catalogues				504	6	2
Sale of Council Badges				4	15	0
Repayment from Warwick Local Committee for Cheese-Shedding ..				50	3	1
Repayment for Judges' Lodgings, not occupied				2	0	6
*Fines for Non-Exhibition of Stock				16	0	0
*Extra Lines in Implement Catalogue				10	7	11
Non-Members' Fees for Entry of Implements ..	£ 42	5	0			
Implement-Makers' Payment for Shedding	856	4	0			
Fees for Entry of Live Stock	441	15	0			
Fees for Entry of Cheese and Wool	12	10	0			
	1352	14	0			
Deficit of late Secretary	422	15	3			
Balance paid in to Bankers				929	18	9
				£8478	16	4

* Fines remaining unpaid :—Live stock, 12*l.*; Implements, 3*l.* 1*s.*

† Prizes remaining unpaid :—Two, amounting to 20*l.*, withheld until the animal in each case shall have been certified to have produced a live calf before January 31st, 1860.

ACCOUNT.—WARWICK, 1859.

EXPENDITURE.	£.	s.	d.
Show and Trial Yard Works	2508	15	1
Extras in Show Yard	342	3	1
Hire of Entrance Turnstiles	70	0	0
Hire of Hurdles	163	6	8
Judges of Implements	140	0	0
" Stock	232	0	0
" Cheese and Wool	32	0	0
Consulting Engineer and Assistants	100	1	6
Veterinary Inspectors and Assistant	42	0	0
Lodgings for Stewards, Judges, &c.	136	14	0
Refreshments for ditto	50	17	0
Yardmen, Watchmen, and Labourers	142	6	0
Superintendents and Sellers of Catalogues	17	17	0
Index-Clerk and Money-Takers	42	0	0
Foremen of Cattle and Implement-Yards and Fields	33	7	0
Exhibitors' Door-keeper and Money-changer	11	11	0
Gratuities to ditto ditto	8	8	0
Director's Clerks and Assistants	57	18	4
Bankers' Clerks	16	16	0
Extra Clerk	33	0	0
Hay and Straw	128	6	6
Vetches	91	0	0
Clover	56	8	9
Coals	10	7	5
Clay	5	2	0
Hire of Horses	158	11	0
Twine	3	10	0
Surveying Crops	0	13	0
Metropolitan Police	100	10	2
Stationery and Postage-Stamps for Director	25	10	11
Badges for Members of Council, Stewards, Judges, &c.	9	16	6
Prize-Sheets	31	5	0
Certificates	28	2	0
Railway Papers	17	17	6
Programmes	6	19	0
Labels, Admission Orders, Tickets, Circulars, &c.	97	3	6
Implement Catalogues	392	7	9
Stock Catalogues	133	8	0
Implement and Cheese Award Lists	12	0	0
Stock Award Lists	85	4	6
Posters	21	5	0
Packing-Cases and Carriage of Catalogues	14	12	6
Advertisements	137	7	6
Postage and Carriage	25	0	2
Sundry small Bills at Warwick	8	13	7
Fees Returned	2	0	0
Implement Prizes Awarded and Paid	190	0	0
†Live Stock Prizes Awarded and Paid	1467	0	0
Medals	17	6	6
Official Staff: Travelling Expenses, Board, Lodging, &c.	9	13	8
	£7468	3	1

(Signed) A. N. HOOD.
RICHARD MILWARD.
T. W. BRAMSTON.
WM. FISHER HOBBS.

Essays and Reports.—PRIZES FOR 1860.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. AGRICULTURE OF BERKSHIRE.

Fifty Sovereigns will be given for the best Report on the Agriculture of Berkshire.

The principal geological and physical features of the county should be described; the nature of the Soil and character of the Farming in its different districts or natural divisions; its Live Stock; Implements; striking changes of Farm Management since the date of Report to the Board of Agriculture; Improvements recently introduced or still required; remarkable or characteristic Farms.

II. APPLICATION OF MANURE.

Twenty Sovereigns will be given for an approved Essay on the best period of the Rotation and the best time of year for applying the Manure of the Farm.

III. INFLUENCE OF PRICES ON FARM MANAGEMENT.

Ten Sovereigns will be given for the best Essay on the alterations rendered advisable in the Management of Land of different qualities, by low prices of Grain and high prices of Meat.

Competitors will be expected to point out the best mode of maintaining the aggregate farm returns, by making increased receipts from live stock compensate for a fall in the value of grain.

IV. LATE IMPROVEMENTS IN DAIRY PRACTICE.

Ten Sovereigns will be given for the best Essay on recent improvements in Dairy Practice.

A detailed account should be given of any improvements in the management or machinery employed in the manufacture of Cheese or Butter which have been recently adopted, and which have been found to increase the quantity or improve the quality of the produce.

V. THE PROPER OFFICE OF STRAW ON A FARM.

Ten Sovereigns will be given for the best Essay on the proper office of Straw on the Farm.

The Essay must be based upon the teachings of both Practice and Science, in order that a proper value may be assigned to the nutritive qualities of Straw as cattle food, and to its fertilizing properties when used simply as manure. The extent to which it should be used as fodder and litter respectively, and the most approved and economical methods of employing it for either purpose, should be discussed.

VI. FARM CAPITAL.

TEN SOVEREIGNS will be given for the best Essay on the Amount of Capital required for the profitable occupation of a Farm.

The great differences existing between different farms as to soil, climate, style of agriculture, proportion of grass-land, &c., should be taken into account. The proper distribution of capital should be specified under general heads, as well as the total amount required.

VII. SEED-BED FOR AGRICULTURAL CROPS.

TEN SOVEREIGNS will be given for the best Essay on the conditions of Seed-bed best suited to the various agricultural crops.

The writer should first point out, in the case of all ordinary farm crops, the conditions of seed-bed most conducive to healthy vegetation, with reference to firmness, fineness of texture, and moisture, on soils of different quality, and then describe the agricultural operations best calculated to attain the desired result. The quantity of seed per acre; its mode of deposit; depth of covering; subsequent rolling, harrowing, &c., should be considered.

VIII. ADULTERATION OF SEEDS.

TEN SOVEREIGNS will be given for the best Essay on the Adulteration of Agricultural Seeds.

Reliable data should be furnished, founded upon a sufficiently extended experience and observation of ordinary market samples, showing the proportion often met with of seeds that have lost their vegetative power, or of the seeds of weeds. The writer should also point out the readiest mode of detecting adulteration.

IX. ANY OTHER AGRICULTURAL SUBJECT.

TEN SOVEREIGNS will be given for the best Essay on any other agricultural subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1860. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.*

Awards, 1859.

Class II.

The Prize of 25*l.* for the best Report on the Agriculture of the Channel Islands, was awarded to Mr. C. P. Le Cornu, of Beaumont, Jersey.

The Report by Mr. F. F. Dally, of Osprey Villa, Guernsey, was highly commended.

Class III.

The Prize of 25*l.* for the best Account of the Application of Steam Power to the Cultivation of the Land, was awarded to Mr. John Algernon Clarke, of Long Sutton, Lincolnshire.

Classes VI. and VII.

The Essays in these Classes were not considered deserving of the Prizes offered.

In Class I. there was no competition.

H. S. Thompson,
Chairman of the Journal Committee.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Members' Privileges of Chemical Analysis.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for the *bonâ-fide* use of Members of the Society; who (to avoid all unnecessary correspondence) are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.	—An opinion of the genuineness of Peruvian guano, bone-dust, or oil-cake (each sample)	5s
„ 2.	—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia	10s.
„ 3.	—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda	10s.
„ 4.	—An analysis of superphosphate of lime for soluble phosphates only	10s.
„ 5.	—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia ..	£1.
„ 6.	—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure	£1.
„ 7.	—Limestone:—the proportion of lime, 7*s.* 6*d.*; the proportion of magnesia, 10*s.*; the proportion of lime and magnesia	15s.
„ 8.	—Limestone or marls, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay ..	£1.
„ 9.	—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1.
„ 10.	—Complete analysis of a soil	£3.
„ 11.	—An analysis of oil-cake, or other substance used for feeding purposes; showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate	£1.
„ 12.	—Analyses of any vegetable product	£1.
„ 13.	—Analyses of animal products, refuse substances used for manure, &c.	from 10s. to 30s.
„ 14.	—Determination of the "hardness" of a sample of water before and after boiling	10s.
„ 15.	—Analysis of water of land drainage, and of water used for irrigation	£2.
„ 16.	—Determination of nitric acid in a sample of water	£1.

N.B.—*The above Scale of Charges is not applicable to the case of persons commercially engaged in the Manufacture or Sale of any Substance sent for Analysis.*

The Address of Professor Voelcker, the Consulting Chemist of the Society, is Cirencester, Gloucestershire, to which he requests that all letters and parcels (postage and carriage paid) should be directed: for the convenience, however, of persons residing in London, parcels sent to the Society's Office, No. 12, Hanover Square, will be forwarded to Cirencester once or twice a week.

Members' Veterinary Privileges.

I.—Veterinary Inspection.

No. 1. Any member of the Society who may desire a competent professional opinion and special advice in cases of extensive or destructive disease among his stock, and will address a letter to the Secretary, will, by return of post, receive a printed list of queries, to be filled up and returned to him immediately. On the receipt of such returned list, the Secretary will convene the Veterinary Committee forthwith (any two Members of which, with the assistance of the Secretary, will be competent to act); and such Committee will decide on the necessity of despatching Professor Simonds, the Society's Veterinary Inspector, to the spot where disease is said to prevail.

No. 2. The remuneration of such Inspector will be 2*l.* 2*s.* each day as a professional fee, and 1*l.* 1*s.* each day on account of personal expenses; and he will also be allowed to charge the cost of travelling to and from the localities where his services may have been thus required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant for professional aid. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them under peculiar circumstances by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, shall report to the Committee, in writing, the results of his observations and proceedings, which report will be laid before the Council.

No. 4. Should contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

II.—Investigations, Lectures, and Reports.

No. 1. All Members of the Society have the privilege of sending cattle, sheep, and pigs to the Royal Veterinary College, on the same terms as if they were Members of the College.

No. 2. The College have undertaken to investigate such particular classes of disease, or special subjects connected with the application of the Veterinary art to cattle, sheep, and pigs, as may from time to time be directed by the Council.

No. 3. In addition to the increased number of lectures now given by Professor Simonds, the Lecturer on Cattle Pathology, to the Pupils in the Royal Veterinary College, he will also deliver such lectures before the Members of the Society, at their house in Hanover Square, or at its Annual Meetings in the country, as the Council may decide.

No. 4. The Royal Veterinary College will from time to time furnish to the Council of the Society a detailed Report of the cases of cattle, sheep, and pigs treated in the College.

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